



# **OPERATION and MAINTENANCE MANUALS**

For

**BRISBANE CITY COUNCIL**

At

**BRISBANE WATER**

**SEWAGE PUMP STATION**

**SP078 SANDGATE ROAD**

Manuals Prepared by:

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**REVISION B: July 2003**



**OPERATION and MAINTENANCE MANUALS**

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**Revision Status**

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Prepared by: Jim Pringle

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Reviewed

Project Manager: \_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_





## OPERATION and MAINTENANCE MANUALS

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## OPERATION and MAINTENANCE MANUALS

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### INSTRUCTIONS FOR USE

1. Units placed on site using "Hook Truck" (Cleanaway Type) over cable pit.
2. Cable pit to be under switchboard section of unit (rear).
3. Attach hold down / anti-theft chains to location points at rear of unit (beside switchboard).
4. Check engine lube oil level.
5. Check engine coolant level.
6. Check the battery is connected and the electrolyte level is correct.
7. Connect cables to plugs via colour-coded sequence.
8. Connect power inlet socket (240V).
9. Connect communication socket.
10. Connect pump station control socket.
11. Check fuel level (mechanical gauge beside fill point).
12. Refer to section 6, Functional Description for start/run and connection procedure.
13. Remember **SAFETY** is important **ALWAYS** wear your Personal Protection Equipment (PPE)

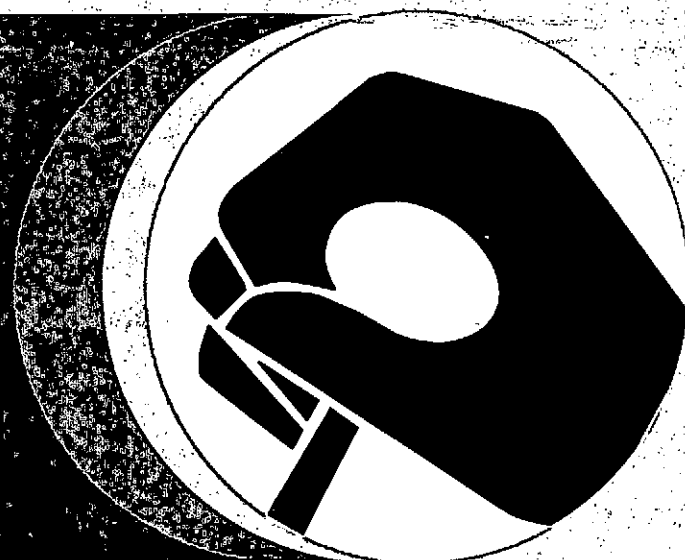






**POWER Units for  
Gensets (Saran)  
2.9L/4039/4.5/6.8L  
(128/008/158/258)**

**OPERATOR'S  
MANUAL**



**John Deere Usine de Saran  
OMCD16564 (03JAN00)**

Printed in Germany  
ENGLISH



# Introduction

THIS MANUAL COVERS the following engines for generator sets:

| ENGINE FAMILY | ENGINE MODEL |
|---------------|--------------|
| 300-SERIES    | CD3029DF128  |
|               | CD4039DF008  |
|               | CD4039TF008  |
| POWERTECH®    | CD4045DF158  |
|               | CD4045HF158  |
|               | CD4045TF158  |
|               | CD4045TF258  |
|               | CD6068HF158  |
|               | CD6068TF158  |
|               | CD6068TF258  |

READ THIS MANUAL carefully to learn how to operate and service your engine correctly. Failure to do so could result in personal injury or equipment damage.

THIS MANUAL SHOULD BE CONSIDERED a permanent part of your engine and should remain with the engine when you sell it.

MEASUREMENTS IN THIS MANUAL are given in metric. Use only correct replacement parts and fasteners. Metric and inch fasteners may require a specific metric or inch wrench.

WRITE ENGINE SERIAL NUMBERS and option codes in the spaces indicated in the Record Keeping Section. Accurately record all the numbers. Your dealer also needs these numbers when you order parts. File the identification numbers in a secure place off the engine or machine.

RIGHT-HAND AND LEFT-HAND sides are determined by standing at the drive or flywheel end (rear) of the engine and facing toward the front of the engine.

SETTING FUEL DELIVERY beyond published factory specifications or otherwise overpowering will result in loss of warranty protection for this engine.

## Information relative to emissions regulations

Depending on final destination, this engine can meet the emissions regulations according to the US Environmental Protection Agency (EPA), California Air Resources Board (CARB) and for Europe, the Directive 97/68/EC relating the measures against the emissions of gaseous and particulates pollutants from internal combustion engines. In this case an emission label is stuck on the engine.

Emission regulations prohibit tampering with the emission-related components listed below which would render that component inoperative or to make any adjustment on the engine beyond published specifications. It is also illegal to install a part or component where the principal effect of that component is to bypass, defeat, or render inoperative any engine component or device which would affect the engine conformance to the emissions regulations. To summarize, it is illegal to do anything except return the engine to its original published specifications.

List of emission-related components:

- Fuel injection pump
- Intake manifold
- Turbocharger
- Charge air cooling system
- Piston

**CALIFORNIA PROPOSITION 65 WARNING**  
Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects and other reproductive harm.

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*All information, illustrations and specifications in this manual are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.*

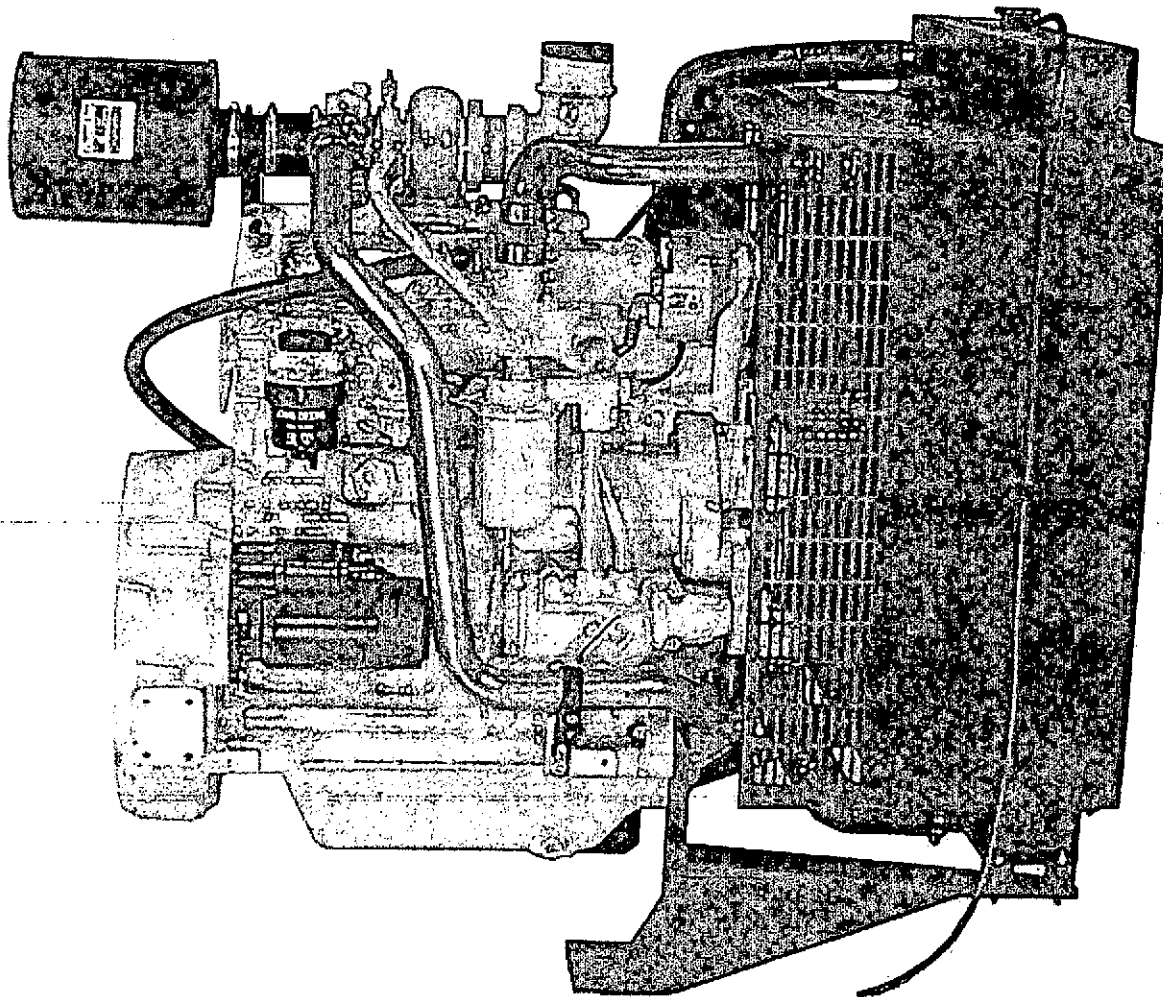
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A John Deere ILLUSTRATION® Manual

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# Identification Views

## IDENTIFICATION VIEWS



4045HF158

CD30744 -UN-23AUG99

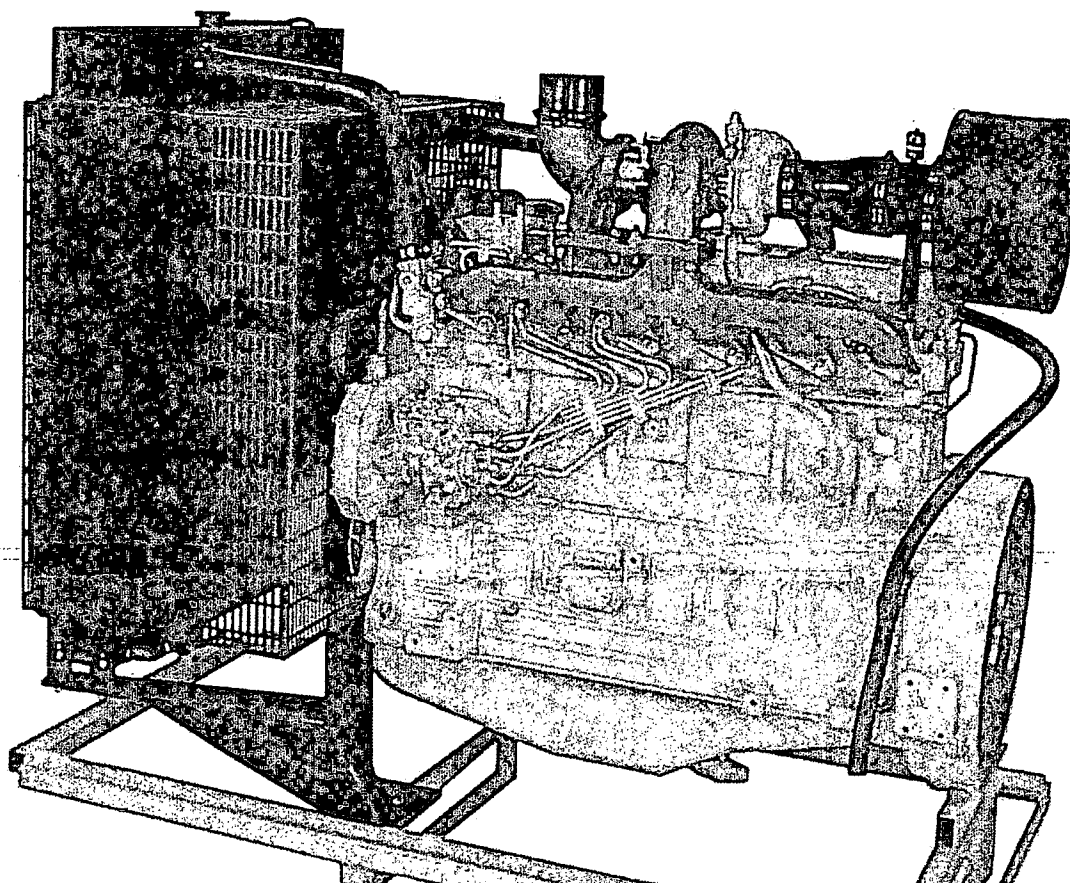
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DPSG,CD03523,3 -19-05JUL99-1/2

01-1

112899  
PN=5

Identification Views



6068HF158

CD30745 -UN-23AUG99

DPSG.CD03523.3 -19-05JUL99-2/2

01-2

112699  
PN=6

# Maintenance Records

## USING MAINTENANCE RECORDS

To obtain the best performance, economy and service life from your engine, ensure service is carried out according to this present manual and recorded in the following pages. It is recommended that your engine Distributor or your Dealer carry out this service work and stamp the appropriate case.

Keeping an accurate account of all service performed on your engine will give more value to the machine when you resell it.

John Deere oils and coolants have been formulated to give maximum protection and performance to your engine. We recommend only genuine John Deere service products and replacement parts.

To protect your rights under the warranty ensure all scheduled services are carried out and recorded. If your engine is covered by extended warranty, it is important to maintain this record for the duration of the warranty.

DPSG,CD03523,6 -19-05JUL99-1/1

## 100 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Hose connections, check

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523,7 -19-05JUL99-1/1

### Maintenance Records

#### 500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
  
- ☐ Fuel filter, replace
  
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
  
- ☐ Valve clearance, adjust (300-Series)

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG.CD03523,8 -19-05JUL99-1/1

#### 1000 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace<br><br><input type="checkbox"/> Engine oil filter, replace<br><br><input type="checkbox"/> Fuel filter, replace<br><br><input type="checkbox"/> Check belt and tensioning system<br><br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Air intake system, check |
|--|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG.CD03523,9 -19-05JUL99-1/1

02-2

112699  
PN=8

### Maintenance Records

#### 1500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523,10 -19-05JUL99-1/1

#### 2000 HOURS OF OPERATION

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li><input type="checkbox"/> Engine oil, replace</li> <li><input type="checkbox"/> Engine oil filter, replace</li> <li><input type="checkbox"/> Fuel filter, replace</li> <li><input type="checkbox"/> Check belt and tensioning system</li> <li>Crankcase vent tube, clean</li> </ul> | <ul style="list-style-type: none"> <li><input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is not used)</li> <li><input type="checkbox"/> Valve clearance, adjust (POWERTech)</li> <li><input type="checkbox"/> Air intake system, check</li> <li><input type="checkbox"/> Vibration damper, check</li> </ul> |
|---|--|

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523,59 -19-16AUG99-1/1

### Maintenance Records

#### 2500 HOURS OF OPERATION

- |   |   |
|---|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Belt, check tension and wear (300-Series and POWERTech with manual tensioner)<br><input type="checkbox"/> Valve clearance, adjust (300-Series) | <input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is used) |
|---|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br>Date:<br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523.60 -19-16AUG99-1/1

#### 3000 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Check belt and tensioning system<br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Air intake system, check |
|--|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br>Date:<br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523.61 -19-16AUG99-1/1

02-4

112699  
PN=10

### Maintenance Records

#### 3500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

Number of hours:

Comments:

Dealer or distributor stamp

Date:

b done by:

DPSG,CD03523,62 -19-16AUG99-1/1

#### 4000 HOURS OF OPERATION

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li><input type="checkbox"/> Engine oil, replace</li> <li><input type="checkbox"/> Engine oil filter, replace</li> <li><input type="checkbox"/> Fuel filter, replace</li> <li><input type="checkbox"/> Check belt and tensioning system</li> <li>Crankcase vent tube, clean</li> </ul> | <ul style="list-style-type: none"> <li><input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is not used)</li> <li><input type="checkbox"/> Valve clearance, adjust (POWERTech)</li> <li><input type="checkbox"/> Air intake system, check</li> <li><input type="checkbox"/> Vibration damper, check</li> </ul> |
|---|--|

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523,63 -19-16AUG99-1/1

02-5

112699  
PN=11

## Maintenance Records

### 4500 HOURS OF OPERATION

- |   |   |
|---|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Belt, check tension and wear (300-Series and POWERTech with manual tensioner)<br><input type="checkbox"/> Valve clearance, adjust (300-Series) | <input type="checkbox"/> Vibration damper, replace (6 cyl.) |
|---|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523,64 -19-16AUG99-1/1

### 5000 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Check belt and tensioning system<br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Injection nozzles, replace<br><input type="checkbox"/> Air intake system, check<br><input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is used) |
|--|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523,65 -19-16AUG99-1/1

**02-6**

112699  
PN=12

## Maintenance Records

**5500 HOURS OF OPERATION**

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523.66 -19-16AUG99-1/1

**6000 HOURS OF OPERATION**

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Check belt and tensioning system
- ☐ Crankcase vent tube, clean
- ☐ Cooling system, drain and flush (if COOL-GARD is not used)
- ☐ Valve clearance, adjust (POWERTech)
- ☐ Air intake system, check
- ☐ Vibration damper, check

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG,CD03523.67 -19-16AUG99-1/1

### Maintenance Records

#### 6500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523.68 -19-16AUG99-1/1

#### 7000 HOURS OF OPERATION

- |  |   |
|--|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Check belt and tensioning system<br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Air intake system, check |
|--|---|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG,CD03523.69 -19-16AUG99-1/1

**02-8**

112699  
PN=14

## Maintenance Records

**7500 HOURS OF OPERATION**

- |   |   |
|---|---|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Belt, check tension and wear (300-Series and POWERTech with manual tensioner)<br><input type="checkbox"/> Valve clearance, adjust (300-Series) | <input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is used) |
|---|---|

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG.CD03523.70 -19-16AUG99-1/1

**8000 HOURS OF OPERATION**

- |   |  |
|---|--|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Check belt and tensioning system<br>Crankcase vent tube, clean | <input type="checkbox"/> Cooling system, drain and flush (if COOL-GARD is not used)<br><input type="checkbox"/> Valve clearance, adjust (POWERTech)<br><input type="checkbox"/> Air intake system, check<br><input type="checkbox"/> Vibration damper, check |
|---|--|

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG.CD03523.71 -19-16AUG99-1/1

### Maintenance Records

#### 8500 HOURS OF OPERATION

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG.CD03523.72 -19-16AUG99-1/1

#### 9000 HOURS OF OPERATION

- |  |  |
|--|--|
| <input type="checkbox"/> Engine oil, replace<br><input type="checkbox"/> Engine oil filter, replace<br><input type="checkbox"/> Fuel filter, replace<br><input type="checkbox"/> Check belt and tensioning system<br><input type="checkbox"/> Crankcase vent tube, clean | <input type="checkbox"/> Air intake system, check<br><input type="checkbox"/> Vibration damper, replace (6 cyl.) |
|--|--|

|   |           |                             |
|---|-----------|-----------------------------|
| Number of hours:<br><br><br>Date:<br><br><br>Job done by: | Comments: | Dealer or distributor stamp |
|---|-----------|-----------------------------|

DPSG.CD03523.73 -19-16AUG99-1/1

**02-10**

112699  
PN=16

## Maintenance Records

**9500 HOURS OF OPERATION**

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Belt, check tension and wear (300-Series and POWERTech with manual tensioner)
- ☐ Valve clearance, adjust (300-Series)

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG.CD03523,74 -19-16AUG99-1/1

**10000 HOURS OF OPERATION**

- ☐ Engine oil, replace
- ☐ Engine oil filter, replace
- ☐ Fuel filter, replace
- ☐ Check belt and tensioning system
- ☐ Crankcase vent tube, clean
- ☐ Air intake system, check
- ☐ Cooling system, drain and flush
- ☐ Valve clearance, adjust (POWERTech)
- ☐ Thermostat, replace
- ☐ Vibration damper, check
- ☐ Injection nozzles, replace

Number of hours:

Comments:

Dealer or distributor stamp

Date:

Job done by:

DPSG.CD03523,75 -19-16AUG99-1/1

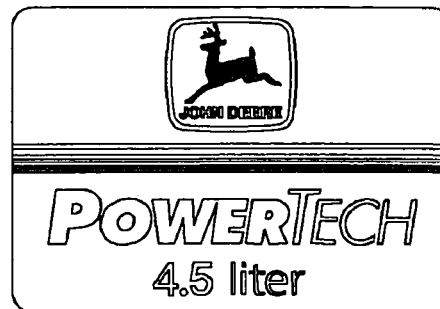
02-11

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PN=17

# Record Keeping

## POWERTECH® MEDALLION

A medallion is located on the rocker arm cover which identifies each engine as a John Deere POWERTECH® engine.

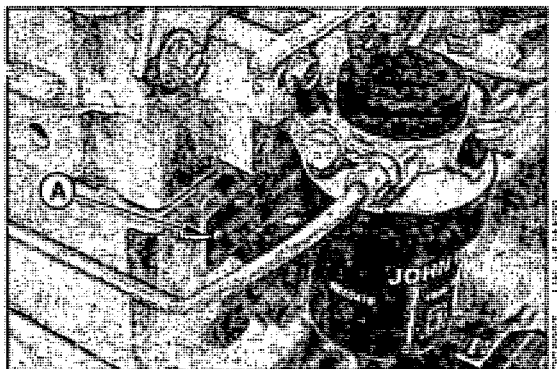


RG8041 -JN-15/JAN99

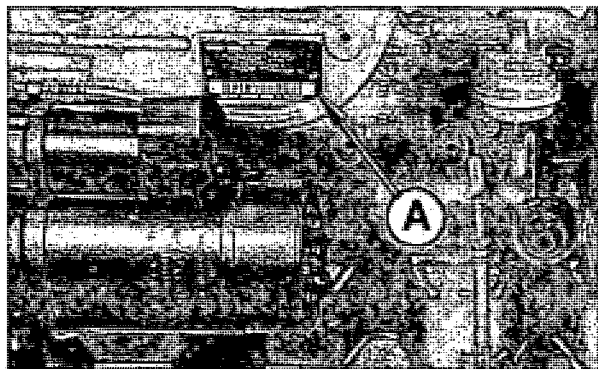
POWERTECH is a trademark of Deere & Company

DPSG,CD03523,11 -19-05JUL99-1/1

## ENGINE SERIAL NUMBER PLATE



POWERTECH engine



300-Series engine

Each engine has a 13-digit John Deere serial number. The first two digits identify the factory that produced the engine:

"CD" indicates the engine was built in Saran, France.

Your engine's serial number plate (A) is located on the right-hand side of cylinder block behind the fuel filter for POWERTECH engines and near the fuel supply pump on 300-Series engines.

DPSG,CD03523,12 -19-05JUL99-1/1

## Record Keeping

**RECORD ENGINE SERIAL NUMBER**

Record all of the numbers and letters found on your engine serial number plate in the spaces provided below.

This information is very important for repair parts or warranty information.

Engine Serial Number (B)

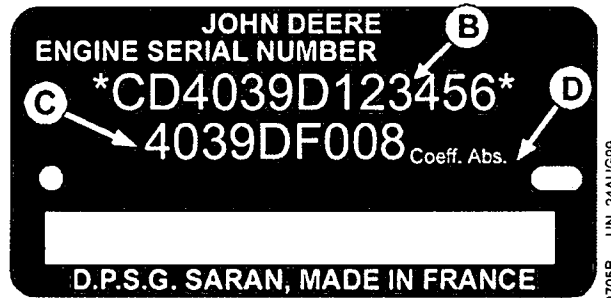
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Engine Model Number (C)

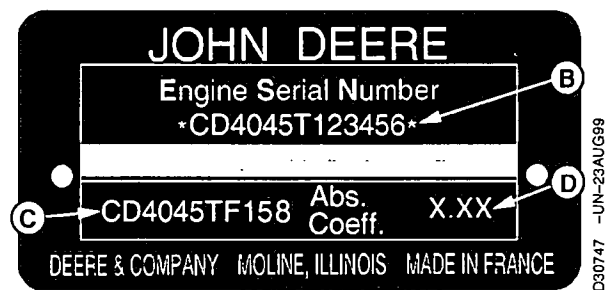
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Coefficient of Absorption Value (D)

\_\_\_\_\_



300-Series engine plate

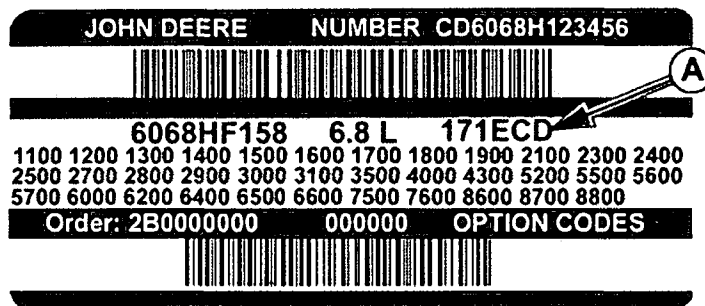


POWERTech engine plate

DPSG,CD03523,13 -19-05JUL99-1/1

## Record Keeping

## ENGINE OPTION CODES



CD30748A -JUN-26AUG99

Engine option code label

In addition to the serial number plate, OEM engines have an engine option code label affixed to the rocker arm cover. These codes indicate which of the engine options were installed on your engine at the factory. When in need of parts or service, furnish your authorized servicing dealer or engine distributor with these numbers.

An additional sticker may be also delivered (in a plastic bag attached to the engine or inserted in the machine documentation). It is recommended to stick this option code list sticker either:

- On this page of your Operator's manual below this section.
- or
- On the "Engine Owner's Warranty" booklet under the title OPTION CODES (Engine manufacturing configuration).

**NOTE:** The Machine Manufacturer may have already stuck it at a specific accessible place (inside the enclosure or close to a maintenance area).

The engine option code label includes an engine base code (A). This base code must also be recorded along with the option codes. At times it will be necessary to furnish this base code to differentiate two identical option codes for the same engine model.

The first two digits of each code identify a specific group, such as alternators. The last two digits of each code identify one specific option provided on your engine, such as a 12-volt, 55-amp alternator.

**NOTE:** These option codes are based on the latest information available at the time of publication. The right is reserved to make changes at any time without notice.

If an engine is ordered without a particular component, the last two digits of that functional group option code will be 99, 00, or XX. The list on the next page shows only the first two digits of the code numbers. For future reference such as ordering repair parts, it is important to have these code numbers available. To ensure this availability, enter the third and fourth digits shown on your engine option code label in the spaces provided on the following page.

**NOTE:** Your engine option code label may not contain all option codes if an option has been added after the engine left the producing factory.

If option code label is lost or destroyed, consult your servicing dealer or engine distributor selling the engine for a replacement.

Continued on next page

DPSG,CD03523.14 -19-05JUL99-1/2

03-3

112699  
PN=20

## Record Keeping

| Option Codes            | Description                       | Option Codes | Description                                 |
|-------------------------|-----------------------------------|--------------|---|
| Engine Base Code: _____ |                                   |              |   |
| 11____                  | Rocker Arm Cover                  | 45____       | Balancer Shaft                              |
| 12____                  | Oil Filler Neck                   | 46____       | Cylinder Block With Liners and Camshaft     |
| 13____                  | Crankshaft Pulley                 | 47____       | Crankshaft and Bearings                     |
| 14____                  | Flywheel Housing                  | 48____       | Connecting Rods and Pistons                 |
| 15____                  | Flywheel                          | 49____       | Valve Actuating Mechanisms                  |
| 16____                  | Fuel Injection Pump               | 50____       | Oil Pump                                    |
| 17____                  | Air inlet                         | 51____       | Cylinder Head With Valves                   |
| 18____                  | Air cleaner                       | 52____       | Auxiliary Gear Drive                        |
| 19____                  | Oil pan                           | 54____       | Oil heater                                  |
| 20____                  | Coolant pump                      | 55____       | Shipping stand                              |
| 21____                  | Thermostat Cover                  | 56____       | Paint Option                                |
| 22____                  | Thermostat                        | 57____       | Coolant Inlet                               |
| 23____                  | Fan Drive                         | 59____       | Oil Cooler                                  |
| 24____                  | Fan Belt                          | 60____       | Add-on Auxiliary Drive Pulley               |
| 25____                  | Fan                               | 62____       | Alternator Mounting                         |
| ____                    | Engine Coolant Heater             | 64____       | Exhaust Elbow                               |
| ____                    | Radiator                          | 65____       | Turbocharger                                |
| 28____                  | Exhaust Manifold                  | 66____       | Temperature Switch                          |
| 29____                  | Ventilator System                 | 67____       | Electronic Tachometer Sensor                |
| 30____                  | Starting Motor                    | 68____       | Damper                                      |
| 31____                  | Alternator                        | 69____       | Engine Serial Number Plate                  |
| 32____                  | Instrument Panel                  | 74____       | Air Conditioning System Compressor Mounting |
| 35____                  | Fuel Filter                       | 75____       | Air Restriction Indicator                   |
| 36____                  | Front Plate                       | 76____       | Oil Pressure Switch                         |
| 37____                  | Fuel Transfer Pump                | 86____       | Fan Pulley                                  |
| 39____                  | Thermostat Housing                | 87____       | Automatic Belt Tensioner                    |
| 40____                  | Oil Dipstick                      | 88____       | Oil Filter                                  |
| 41____                  | Belt Driven Front Auxiliary Drive | 91____       | Special Equipment (Factory Installed)       |
| 43____                  | Starting Aid                      | 97____       | Special Equipment (Field Installed)         |
| 44____                  | Timing Gear Cover with Gears      | 98____       | Shipping                                    |

DPSG,CD03523,14 -19-05JUL99-2/2

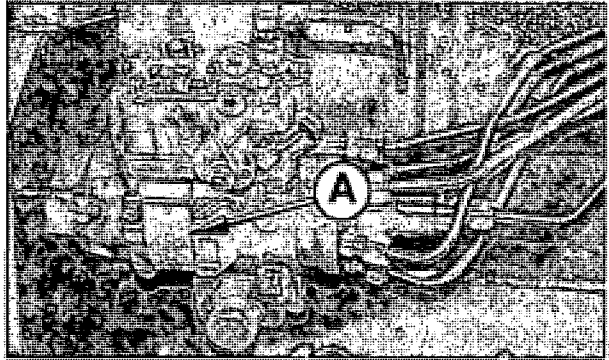
*Record Keeping***RECORD FUEL INJECTION PUMP MODEL NUMBER**

Record the fuel injection pump model and serial information found on the serial number plate (A).

Model No. \_\_\_\_\_ RPM \_\_\_\_\_

Manufacturer's No. \_\_\_\_\_

Serial No. \_\_\_\_\_



OPSG.C003523.15 -19-07JUL99-1/1

# Safety

## RECOGNIZE SAFETY INFORMATION

This is a safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

Follow recommended precautions and safe operating practices.



T81369 -UN-07DEC88

DX.ALERT -19-29SEP98-1/1

## UNDERSTAND SIGNAL WORDS

A signal word—DANGER, WARNING, or CAUTION—is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.



**⚠ WARNING**

**⚠ CAUTION**

TS187 -19-30SEP88

DX.SIGNAL -19-03MAR93-1/1

## Safety

## ENGINE LIFTING PROCEDURE



**CAUTION:** The only recommended method for lifting the engine is with JDG23 Engine Lifting Sling (A) and safety approved lifting straps (B) that come with engine. Use extreme caution when lifting and NEVER permit any part of the body to be positioned under an engine being lifted or suspended.

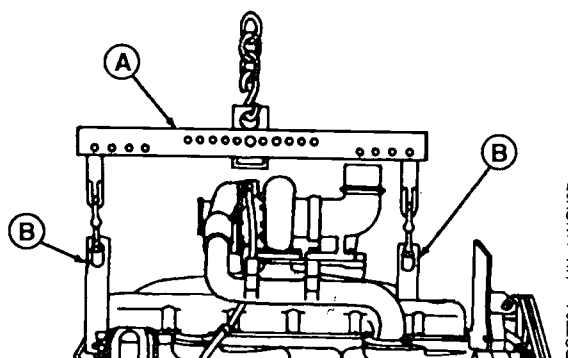
Lift engine with longitudinal loading on lifting sling and lifting straps only. Angular loading greatly reduces lifting capacity of sling and straps.

**NOTE:** If engine does not have lifting straps, universal straps can be procured through service parts under part numbers JD-244-1 and JD-244-2.

1. If not equipped, install lifting straps and torque to 200 N•m (145 lb-ft).
2. Attach JDG23 Engine Lifting Sling (A) to engine lifting straps (B) and overhead hoist.

**IMPORTANT:** Lifting straps are designed to lift the engine and accessories such as radiator, air filter and other small components. If larger components, such as power take-off, transmission, generator air compressor... etc, are attached to engine, the lifting straps provided with engine or through parts channel are not intended for this purpose. Technician is responsible for providing adequate lifting devices under these situations. See machine manuals for additional information on removing engine from machine.

3. Carefully move engine to desired location.



RG7784 -UN-11NOV97

DPSG,CD03523,95 -19-06OCT99-1/1

05-2

112699  
PN=24

## Safety

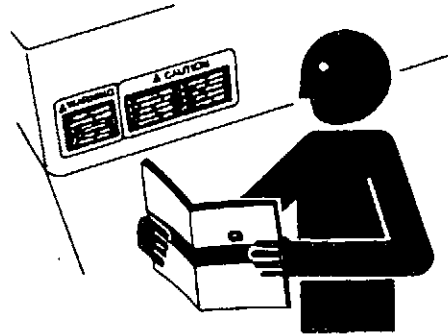
### FOLLOW SAFETY INSTRUCTIONS

Carefully read all safety messages in this manual and on your machine safety signs. Keep safety signs in good condition. Replace missing or damaged safety signs. Be sure new equipment components and repair parts include the current safety signs. Replacement safety signs are available from your John Deere dealer.

Learn how to operate the machine and how to use controls properly. Do not let anyone operate without instruction.

Keep your machine in proper working condition. Unauthorized modifications to the machine may impair the function and/or safety and affect machine life.

If you do not understand any part of this manual and need assistance, contact your John Deere dealer.



TS201 -UN-23AUG88

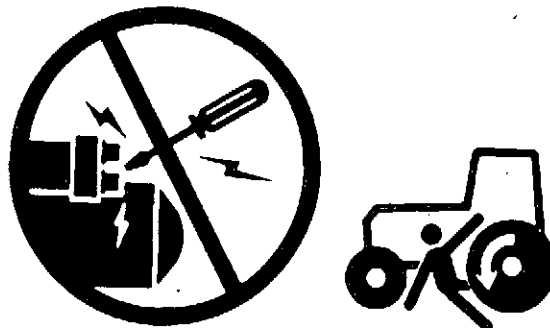
DX,READ -19-03MAR93-1/1

### PREVENT MACHINE RUNAWAY

Avoid possible injury or death from machinery runaway.

Do not start engine by shorting across starter terminals. Machine will start in gear if normal circuitry is bypassed.

NEVER start engine while standing on ground. Start engine only from operator's seat, with transmission in neutral or park.



TS177 -UN-11JAN89

DX,BYPAS1 -19-29SEP98-1/1

## Safety

### HANDLE FUEL SAFELY—AVOID FIRES

Handle fuel with care: it is highly flammable. Do not refuel the machine while smoking or when near open flame or sparks.

Always stop engine before refueling machine. Fill fuel tank outdoors.

Prevent fires by keeping machine clean of accumulated trash, grease, and debris. Always clean up spilled fuel.



TS202 -UN-23AUG88

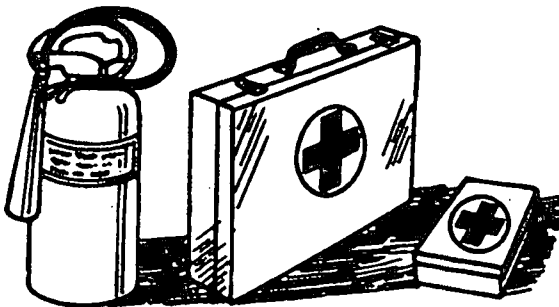
DX,FIRE1 -19-03MAR93-1/1

### PREPARE FOR EMERGENCIES

Be prepared if a fire starts.

Keep a first aid kit and fire extinguisher handy.

Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.



TS201 -UN-23AUG88

DX,FIRE2 -19-03MAR93-1/1

### HANDLE STARTING FLUID SAFELY

Starting fluid is highly flammable.

Keep all sparks and flame away when using it. Keep starting fluid away from batteries and cables.

To prevent accidental discharge when storing the pressurized can, keep the cap on the container, and store in a cool, protected location.

Do not incinerate or puncture a starting fluid container.



TS1356 -UN-18MAR92

DX,FIRE3 -19-16APR92-1/1

## Safety

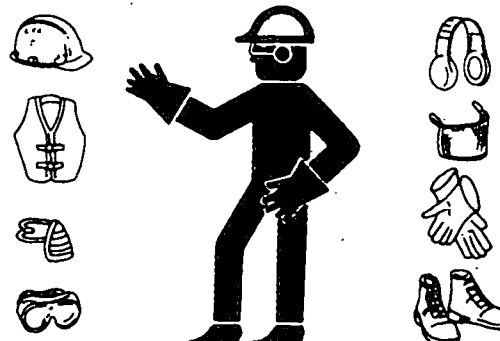
### WEAR PROTECTIVE CLOTHING

Wear close fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.



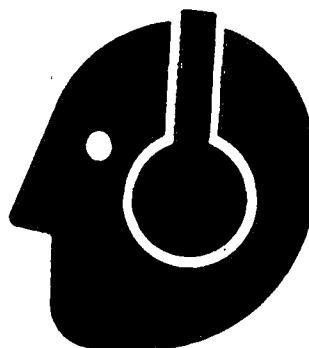
TS206 -UN-23AUG88

DX,WEAR -19-10SEP90-1/1

### PROTECT AGAINST NOISE

Prolonged exposure to loud noise can cause impairment or loss of hearing.

Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.



TS207 -UN-23AUG88

DX,NOISE -19-03MAR93-1/1

## Safety

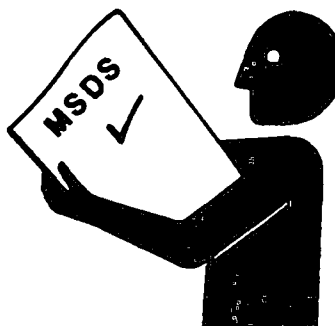
### HANDLE CHEMICAL PRODUCTS SAFELY

Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques.

Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and recommended equipment.

(See your John Deere dealer for MSDS's on chemical products used with John Deere equipment.)



TS1132 -UN-26NOV90

DX,MSDS,NA -19-03MAR93-1/1

### STAY CLEAR OF ROTATING DRIVELINES

Entanglement in rotating driveline can cause serious injury or death.

Keep master shield and driveline shields in place at all times. Make sure rotating shields turn freely.

Wear close fitting clothing. Stop the engine and be sure the PTO driveline is stopped before making adjustments or performing any type service on the engine or PTO-driven equipment.



TS1644 -UN-22AUG95

CD,PTO -19-12SEP95-1/1

## Safety

### PRACTICE SAFE MAINTENANCE

Understand service procedure before doing work. Keep area clean and dry.

Never lubricate, service, or adjust machine while it is moving. Keep hands, feet, and clothing from power-driven parts. Disengage all power and operate controls to relieve pressure. Lower equipment to the ground. Stop the engine. Remove the key. Allow machine to cool.

Securely support any machine elements that must be raised for service work.

Keep all parts in good condition and properly installed. Fix damage immediately. Replace worn or broken parts. Remove any buildup of grease, oil, or debris.

On self-propelled equipment, disconnect battery ground cable (-) before making adjustments on electrical systems or welding on machine.

On towed implements, disconnect wiring harnesses from tractor before servicing electrical system components or welding on machine.



TS218 -UN-23AUG88

DX,SERV -19-17FEB99-1/1

### WORK IN VENTILATED AREA

Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area.



TS220 -UN-23AUG88

DX,AIR -19-17FEB99-1/1

## Safety

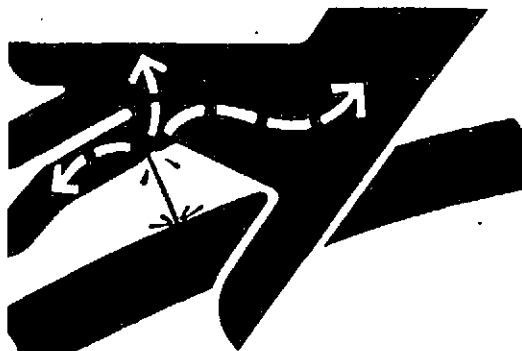
### AVOID HIGH-PRESSURE FLUIDS

Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.



X9811 -UN-23AUG88

DX,FLUID -19-03MAR93-1/1

### AVOID HEATING NEAR PRESSURIZED FLUID LINES

Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.



TS953 -UN-15MAY90

DX,TORCH -19-03MAR93-1/1

## Safety

### REMOVE PAINT BEFORE WELDING OR HEATING

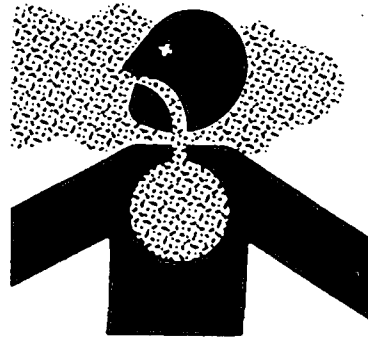
Avoid potentially toxic fumes and dust.

Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch.

Do all work outside or in a well ventilated area. Dispose of paint and solvent properly.

Remove paint before welding or heating:

- If you sand or grind paint, avoid breathing the dust. Wear an approved respirator.
- If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.



TS220 -UN-23AUG88

DX,PAINT -19-03MAR93-1/1

### SERVICE COOLING SYSTEM SAFELY

Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.



TS281 -UN-23AUG88

DX,RCAP -19-04JUN90-1/1

## Safety

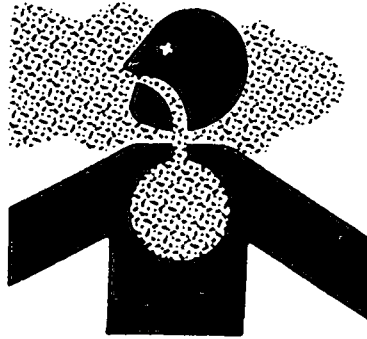
### AVOID HARMFUL ASBESTOS DUST

Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos.

Keep bystanders away from the area.



TS220 -UN-23AUG88

DX,DUST -19-15MAR91-1/1

### DISPOSE OF WASTE PROPERLY

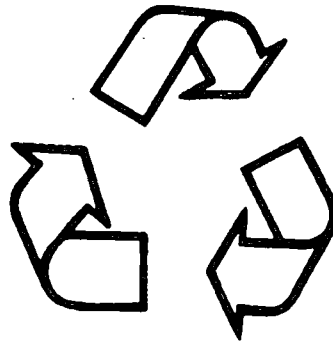
Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries.

Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them.

Do not pour waste onto the ground, down a drain, or into any water source.

Air conditioning refrigerants escaping into the air can damage the Earth's atmosphere. Government regulations may require a certified air conditioning service center to recover and recycle used air conditioning refrigerants.

Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.



TS1133 -UN-26NOV90

DX,DRAIN -19-03MAR93-1/1

05-10

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PN=32

# Fuels, Lubricants and Coolant

## DIESEL FUEL

Consult your local fuel distributor for properties of the diesel fuel available in your area.

In general, diesel fuels are blended to satisfy the low temperature requirements of the geographical area in which they are marketed.

Diesel fuels specified to EN 590 or ASTM D975 are recommended.

In all cases, the fuel shall meet the following properties:

**Cetane number of 40 minimum.** Cetane number greater than 50 is preferred, especially for temperatures below -20°C (-4°F) or elevations above 1,000 m (5,000 ft).

**Cold Filter Plugging Point (CFPP)** below the expected low temperature OR **Cloud Point** at least 5°C (9°F) below the expected low temperature.

**Fuel lubricity** should pass a minimum of 3100 gram load level as measured by the BOCLE scuffing test.

### Sulfur content:

- Sulfur content should not exceed 0.5%. Sulfur content less than 0.05% is preferred.
- If diesel fuel with sulfur content greater than 0.5% sulfur content is used, reduce the service interval for engine oil and filter by 50%.
- DO NOT use diesel fuel with sulfur content greater than 1.0%.

Bio-diesel fuels may be used ONLY if the fuel properties meet DIN 51606 or equivalent specification.

DO NOT mix used engine oil or any other type of lubricant with diesel fuel.

DX,FUEL1 -19-17FEB99-1/1

## HANDLING AND STORING DIESEL FUEL



**CAUTION:** Handle fuel carefully. Do not fill the fuel tank when engine is running.

**DO NOT smoke while you fill the fuel tank or service the fuel system.**

Fill the fuel tank at the end of each day's operation to prevent condensation and freezing during cold weather.

**IMPORTANT:** The fuel tank is vented through the filler cap. If a new filler cap is required, always replace it with an original vented cap.

When fuel is stored for an extended period or if there is a slow turnover of fuel, add a fuel conditioner to stabilize the fuel and prevent water condensation. Contact your fuel supplier for recommendations.

DX,FUEL4 -19-18MAR96-1/1

*Fuels, Lubricants and Coolant***ENGINE BREAK-IN OIL**

New engines are filled at the factory with John Deere ENGINE BREAK-IN OIL. During the break-in period, add John Deere ENGINE BREAK-IN OIL as needed to maintain the specified oil level.

Change the oil and filter after the first 100 hours of operation of a new or rebuilt engine.

After engine overhaul, fill the engine with John Deere ENGINE BREAK-IN OIL.

If John Deere ENGINE BREAK-IN OIL is not available, use a diesel engine oil meeting one of the following during the first 100 hours of operation:

- API Service Classification CE

- ACEA Specification E1

After the break-in period, use John Deere PLUS-50® or other diesel engine oil as recommended in this manual.

**IMPORTANT:** Do not use PLUS-50 oil or engine oils meeting API CG4, API CF4, ACEA E3, or ACEA E2 performance levels during the first 100 hours of operation of a new or rebuilt engine. These oils will not allow the engine to break-in properly.

*PLUS-50 is a registered trademark of Deere & Company.*

DX,ENOil4 -19-10OCT97-1/1

## Fuels, Lubricants and Coolant

### DIESEL ENGINE OIL

Use oil viscosity based on the expected air temperature range during the period between oil changes.

The following oil is preferred:

- John Deere PLUS-50®

The following oil is also recommended:

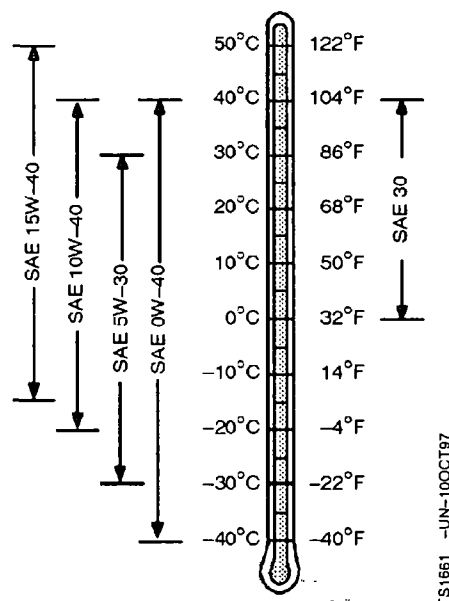
- John Deere TORQ-GARD SUPREME TORQ-GARD SUPREME®

Other oils may be used if they meet one or more of the following:

- API Service Classification CG-4
- ~~API Service Classification CF-4~~
- ACEA Specification E3
- ACEA Specification E2

**Multi-viscosity diesel engine oils are preferred.**

If diesel fuel with sulfur content greater than 0.5% is used, reduce the service interval by 50%.



PLUS-50 is a registered trademark of Deere & Company.  
TORQ-GARD SUPREME is a trademark of Deere & Company

CD,ENOIL -19-10OCT97-1/1

### LUBRICANT STORAGE

Our equipment can operate at top efficiency only when clean lubricants are used.

Use clean containers to handle all lubricants.

Whenever possible, store lubricants and containers in an area protected from dust, moisture, and other contamination. Store containers on their side to avoid water and dirt accumulation.

Make certain that all containers are properly marked to identify their contents.

Properly dispose of all old containers and any residual lubricant they may contain.

DX,LUBST -19-18MAR96-1/1

## *Fuels, Lubricants and Coolant*

### **MIXING OF LUBRICANTS**

In general, avoid mixing different brands or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements.

Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Consult your John Deere dealer to obtain specific information and recommendations.

OX.LUBMIX -19-18MAR96-1/1

### **DIESEL ENGINE COOLANT**

The engine cooling system is filled to provide year-round protection against corrosion and cylinder liner pitting, and winter freeze protection to -37°C (-34°F).

**John Deere COOL-GARD is preferred for service.**

If John Deere COOL-GARD is not available, use a low silicate ethylene glycol base coolant concentrate in a 50% mixture of concentrate with quality water.

The coolant concentrate shall be of a quality that provides cavitation protection to cast iron and aluminum parts in the cooling system. John Deere COOL-GARD meets this requirement.

A 50% mixture of ethylene glycol engine coolant in water provides freeze protection to -37°C (-34°F). If protection at lower temperatures is required, consult your John Deere dealer for recommendations.

Water quality is important to the performance of the cooling system. Distilled, deionized, or demineralized

water is recommended for mixing with ethylene glycol base engine coolant concentrate.

**IMPORTANT: Do not use cooling system sealing additives or antifreeze that contains sealing additives.**

#### **COOLANT DRAIN INTERVALS**

Drain the factory fill engine coolant, flush the cooling system, and refill with new coolant after the first 3 years or 3000 hours of operation. Subsequent drain intervals are determined by the coolant used for service. At each interval, drain the coolant, flush the cooling system, and refill with new coolant.

When John Deere COOL-GARD is used, the coolant drain interval is 3 years or 3000 hours of operation.

If COOL-GARD is not used, the drain interval is reduced to 2 years or 2000 hours of operation.

DX.COOL8 -19-12FEB99-1/1

*Fuels, Lubricants and Coolant***OPERATING IN WARM TEMPERATURE CLIMATES**

John Deere engines are designed to operate using glycol base engine coolants.

Always use a recommended glycol base engine coolant, even when operating in geographical areas where freeze protection is not required.

**IMPORTANT:** *Water may be used as coolant in emergency situations only.*

Foaming, hot surface aluminum and iron corrosion, scaling, and cavitation will occur when water is used as the coolant, even when coolant conditioners are added.

Drain cooling system and refill with recommended glycol base engine coolant as soon as possible.

DX.COOL6 -19-18MAR96-1/1

# Operating the Engine

## BREAK-IN PERIOD

### Within first 100 hours of operation

During the first 100 hours of operation, avoid overloading, excessive idling and no-load operation.

See ENGINE BREAK-IN OIL for eventual addition of oil.

**NOTE:** During the break-in period a higher-than-usual oil consumption should be considered as normal.

### After first 100 hours of operation

After the first 100 hours, drain the crankcase and

change the oil filter (see CHANGING ENGINE OIL AND FILTER). Fill crankcase with seasonal viscosity grade oil (see DIESEL ENGINE OIL).

Check tension of alternator belt.

Check connections of air intake hoses.

Check for proper tightening of cap screws all around the engine.

DPSG,CD03523,17 -19-09JUL99-1/1

## STARTING THE ENGINE



**CAUTION:** Before starting engine in a confined building, install proper outlet exhaust ventilation equipment. Always use safety approved fuel storage and piping.

**NOTE:** If temperature is below 0°C (32°F), it may be necessary to use cold weather starting aids (See COLD WEATHER OPERATION).

1. Perform all prestarting checks outlined in Maintenance/Daily Section.

2. Open the fuel supply shut-off valve, if equipped.

3. Activate the starter motor switch to crank the engine and release it as soon as engine starts.

**NOTE:** Do not operate the starter motor more than 20 seconds at a time.

DPSG,CD03523,18 -19-09JUL99-1/1

## COLD WEATHER OPERATION

Depending on equipment, various cold weather starting aids are available to assist in starting the engine at temperatures below 0°C (32°F).

Continued on next page

DPSG,CD03523,19 -19-09JUL99-1/4

## Operating the Engine

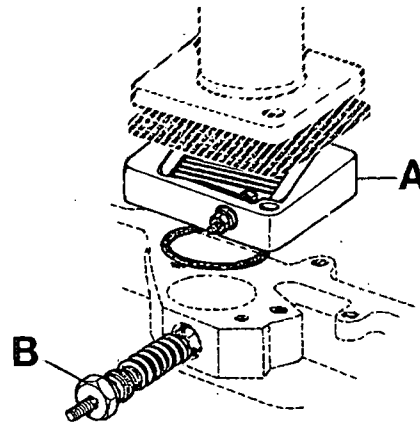
### Air intake heater

Air intake heater is either a grid-type (A) for POWERTech engines or a glow plug-type (B) for 300-Series engines installed in the air intake channel.



**CAUTION: NEVER use Ether Starting Fluid when air intake heater is used to start the engine.**

Activate the heating element (preheater position) for 30 seconds maximum then start the engine.



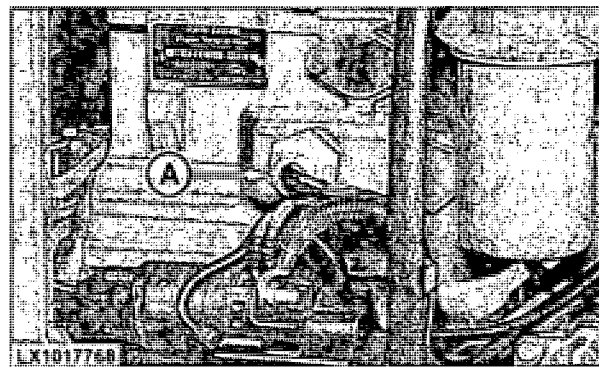
CD30750 -UN-03SEP99

DPSG.CD03523.19 -19-09JUL99-2/4

### Coolant heater

Connect plug of coolant heater (A) to a power source (110 or 220 V).

At an ambient temperature of  $-15^{\circ}\text{C}$  ( $5^{\circ}\text{F}$ ), the heating process takes approximately 2 hours. Extend heating period if ambient temperature is lower.

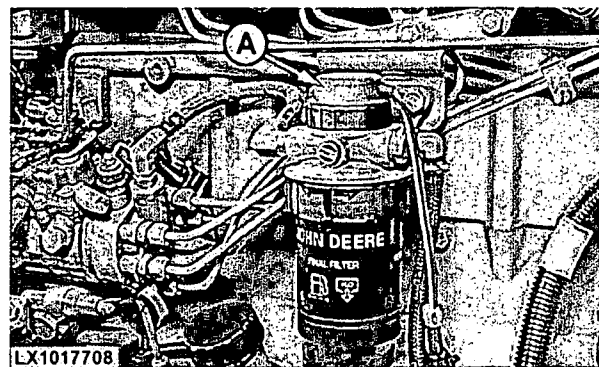


LX1017768 -UN-24OCT97

DPSG.CD03523.19 -19-09JUL99-3/4

### Fuel preheater

el preheater (A) switches ON and OFF automatically in relation to the ambient temperature.



LX1017708 -UN-09OCT97

DPSG.CD03523.19 -19-09JUL99-4/4

## Operating the Engine

## USING A BOOSTER BATTERY OR CHARGER

A 12-volt booster battery can be connected in parallel with battery(ies) on the unit to aid in cold weather starting. ALWAYS use heavy duty jumper cables.

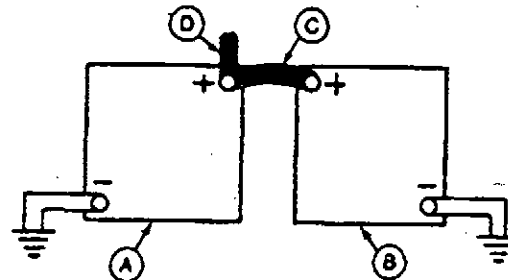
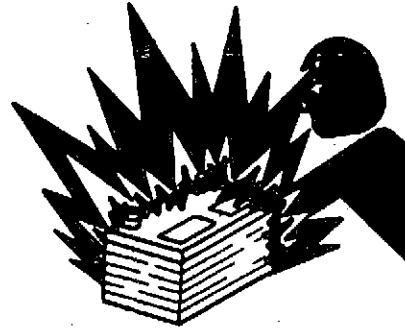
**CAUTION:** Gas given off by batteries is explosive. Keep sparks and flames away from batteries. Before connecting or disconnecting a battery charger, turn charger off. Make last connection and first disconnection at a point away from battery. Always connect **NEGATIVE (-)** cable last and disconnect this cable first.

**IMPORTANT:** Be sure polarity is correct before making connections. Reversed polarity will damage electrical system. Always connect positive to positive and negative to ground. Always use 12-volt booster battery for 12-volt electrical systems and 24-volt booster battery/batteries for 24-volt electrical systems.

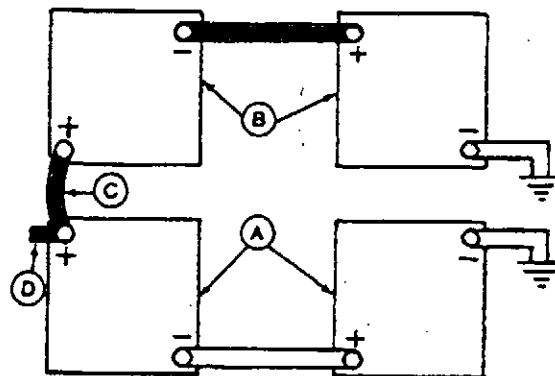
1. Connect booster battery or batteries to produce the required system voltage for your engine application.

**NOTE:** To avoid sparks, DO NOT allow the free ends of jumper cables to touch the engine.

2. Connect one end of jumper cable to the **POSITIVE (+)** post of the booster battery.
3. Connect the other end of the jumper cable to the **POSITIVE (+)** post of battery connected to starter.
4. Connect one end of the other jumper cable to the **NEGATIVE (-)** post of the booster battery.
5. ALWAYS complete the hookup by making the last connection of the **NEGATIVE (-)** cable to a good ground on the engine frame and away from the battery(ies).
6. Start the engine. Disconnect jumper cables immediately after engine starts. Disconnect **NEGATIVE (-)** cable first.



12-Volt System



24-Volts System

A—12-Volt Machine battery/batteries  
B—12-Volt Booster battery/batteries  
C—Booster cable  
D—Cable to starter motor

TS204 -UN-23AUG88

RG4678 -UN-14DEC88

RG4698 -UN-14DEC88

DPSG.CD03523.20 -19-09JUL99-1/1

## Operating the Engine

### ENGINE OPERATION

#### Warming engine

Operate engine at high idle for 1 to 2 minutes before applying the load.

*NOTE: This procedure does not apply to standby generator sets where the engine is loaded immediately upon reaching rated speed.*

#### Normal engine operation

Compare engine coolant temperature and engine oil pressure with specifications below:

##### Minimum oil pressure at full load rated speed<sup>1</sup>—Specification

Pressure..... 275 kPa (2.75 bar; 40 psi)

##### Coolant temperature range—Specification

Temperature ..... 82°—94°C (180°—202°F)

Stop engine immediately if coolant temperature is above or oil pressure below specifications or if there are any signs of part failure. Symptoms that may be early signs of engine problems could be:

- Sudden loss of power

- Unusual noise or vibration
- Excessive black exhaust fumes
- Excessive fuel consumption
- Excessive oil consumption
- Fluid leaks

#### Recommendation for turbocharger engines

Should the engine stall when operating under load, IMMEDIATELY restart it to prevent overheating of turbocharger components.

#### Idling engine

Avoid excessive engine idling. Prolonged idling may cause the engine coolant temperature to fall below its normal range. This, in turn, causes crankcase oil dilution, due to incomplete fuel combustion, and permits formation of gummy deposits on valves, pistons and piston rings. It also promotes rapid accumulation of engine sludge and unburned fuel in the exhaust system. If an engine will be idling for more than 5 minutes, stop and restart later.

*NOTE: Generator set applications have the governor locked at a specified speed and do not have a slow idle function. These engines idle at no load governed speed (fast idle).*

<sup>1</sup>Oil at normal operating temperature of 115°C (240°F).

DPSG.CD03523.21 -19-09JUL99-1/1

### STANDBY POWER UNITS

To assure that your engine will deliver efficient standby operation when needed, start engine and run at rated speed (with 50%—70% load) for 30 minutes every

2 weeks. DO NOT allow engine to run an extended period of time with no load.

DPSG.CD03523.22 -19-09JUL99-1/1

*Operating the Engine***STOPPING THE ENGINE**

1. Before stopping, run engine for at least 2 minutes at fast idle and no load.
2. Stop the engine.

DPSG.CD03523,23 -19-09JUL99-1/1

# Maintenance

## OBSERVE SERVICE INTERVALS

Using hour meter as a guide, perform all services at the hourly intervals indicated on following pages. At each scheduled maintenance interval, perform all previous maintenance operations in addition to the ones specified. Keep a record of hourly intervals and services performed using charts provided in Maintenance Records Section.

**IMPORTANT:** Recommended service intervals are for normal operating conditions. Service **MORE OFTEN** if engine is operated under adverse conditions. Neglecting maintenance can result in failures or permanent damage to the engine.

DPSG,CD03523,24 -19-09JUL99-1/1

## USE CORRECT FUELS, LUBRICANTS AND COOLANT

**PORTANT:** Use only fuels, lubricants, and coolants meeting specifications outlined in Fuels, Lubricants, and Coolant Section when servicing your John Deere Engine.

Consult your John Deere engine distributor, servicing dealer or your nearest John Deere Parts Network for recommended fuels, lubricants, and coolant. Also available are necessary additives for use when operating engines in tropical, arctic, or any other adverse conditions.



TS100 -UN-23AUG88

DPSG,CD03523,25 -19-09JUL99-1/1

## Maintenance

## MAINTENANCE INTERVAL CHART

| Item   | 10 H /<br>daily | 500 H | 1000 H /<br>1 year | 2000 H /<br>2 years | 2500 H /<br>3 years | As<br>required |
|--|-----------------|-------|--------------------|---------------------|---------------------|----------------|
| Check engine oil and coolant level                                   | •               |       |                    |                     |                     |                |
| Check air filter restriction indicator <sup>a</sup>                  | •               |       |                    |                     |                     |                |
| Change engine oil and filter <sup>b</sup>                            |                 | •     |                    |                     |                     |                |
| Replace fuel filter element  |                 | •     |                    |                     |                     |                |
| Check belt tension and automatic tensioner <sup>c</sup>              |                 | •     | •                  |                     |                     |                |
| Check and adjust valve clearance <sup>d</sup>                        |                 |       | •                  | •                   |                     |                |
| Clean crankcase vent tube  |                 |       | •                  |                     |                     |                |
| Check air intake hoses, connections and system                       |                 |       | •                  |                     |                     |                |
| Check vibration damper (6 cyl.) <sup>e</sup>                         |                 |       |                    | •                   |                     |                |
| Check engine speed and speed droop governor                          |                 |       |                    | •                   |                     |                |
| Drain and flush cooling system <sup>f</sup>                          |                 |       |                    | •                   | •                   |                |
| Drain water and sediment from fuel filter                            |                 |       |                    |                     |                     | •              |
| Clean filter element (see note a)                                    |                 |       |                    |                     |                     | •              |
| Test thermostat and injection nozzles (see your dealer) <sup>g</sup> |                 |       |                    |                     |                     | •              |

<sup>a</sup>Clean air filter element when restriction indicator is red. Replace filter element after 6 cleanings or once a year.

<sup>b</sup>Change oil and filter after the first 100 hours of operation, then every 500 hours thereafter. Change oil and filter at least once a year.

<sup>c</sup>Check belt tension every 500 hours on 300-Series engines and on POWERTech engines with manual tensioner. Check automatic belt tensioner every 1000 hours/1 year on POWERTech engines when equipped.

<sup>d</sup>Have your authorized servicing dealer or engine distributor adjust valve clearance as follows. After the first 500 hours of operation then every 1000 hours thereafter on 300-Series engines. Every 2000 hours on POWERTech engines.

<sup>e</sup>Have your authorized dealer or engine distributor replace the vibration damper every 4500 hours/5 years.

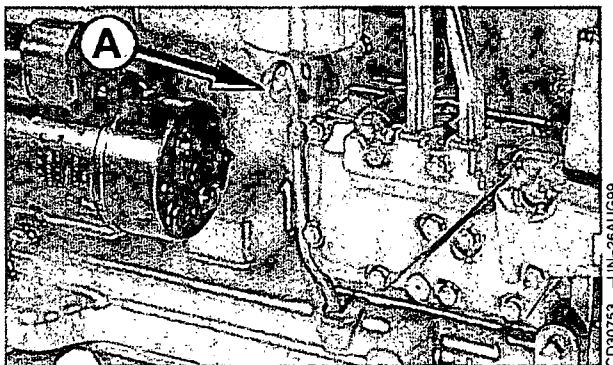
<sup>f</sup>Drain and flush cooling system every 2500 hours/3 years when John Deere COOL-GARD coolant is used. Otherwise every 2000 hours/2 years.

<sup>g</sup>Contact your dealer when thermostat or injection nozzles are suspected to be defective. Replace injection nozzles every 5000 hours and thermostat every 10000 hours.

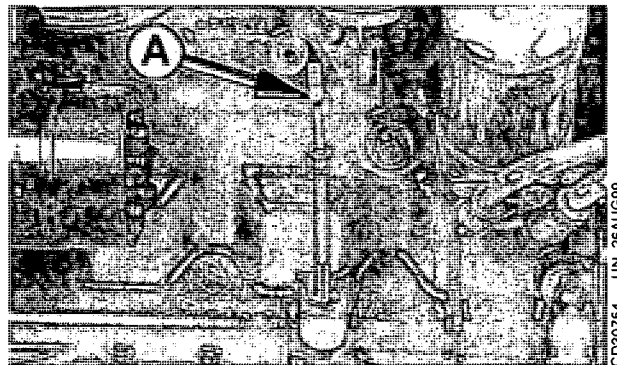
DPSG.CD03523.26 -19-09JUL99-1/1

# Maintenance/Daily or every 10 hours

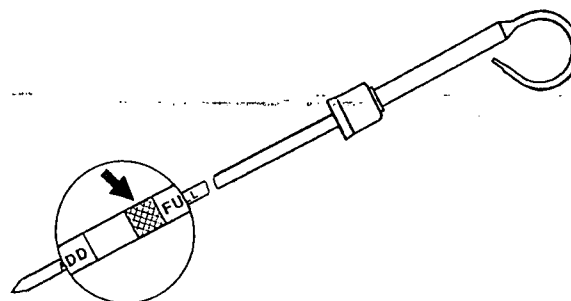
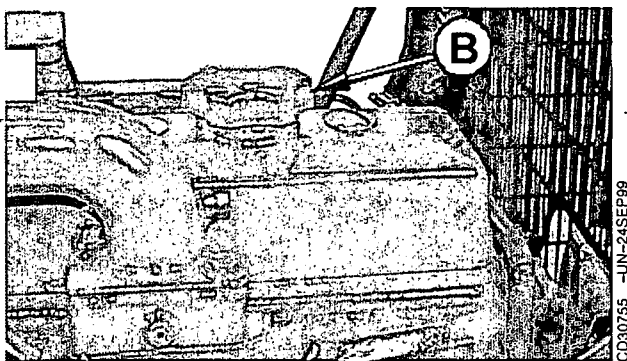
## DAILY PRESTARTING CHECKS



POWERTech engine



300-Series engine



FD000047

FD000047 -UN-13MAR96

Do the following **BEFORE STARTING THE ENGINE** for the first time each day:

**IMPORTANT: DO NOT** top up with fresh oil until the oil level is **BELOW** the add mark.

1. Check engine oil level on dipstick (A). Add as required, using seasonal viscosity grade oil. (See

**DIESEL ENGINE OIL**). Add oil at rocker arm cover filler cap (B).

**IMPORTANT: DO NOT** fill above the crosshatch area. Oil levels anywhere within crosshatch are considered in the acceptable operating range.

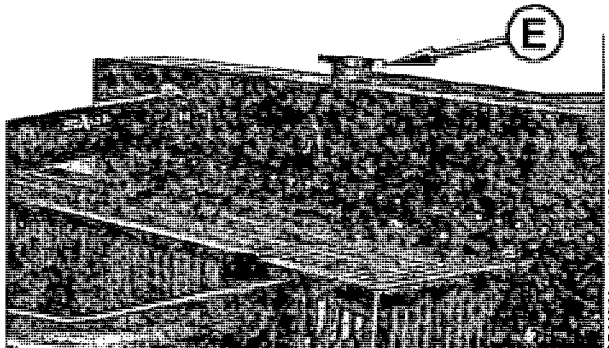
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DPSG,CD03523.27 -19-12JUL99-1/3

## Maintenance/Daily or every 10 hours



TS281 -UN-23AUG88



CD30756 -UN-26AUG99

2. **CAUTION:** Explosive release of fluids from pressurized cooling system can cause serious burns.

Remove radiator cap (E) and check coolant level which should be at bottom of filler neck. Fill radiator with proper coolant solution if level is low. (See DIESEL ENGINE COOLANT). Check overall cooling system for leaks.

Only remove filler cap when engine is cold or when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

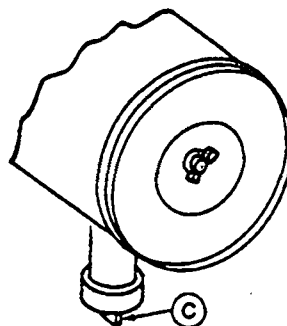
DPSG,CD03523,27 -19-12JUL99-2/3

3. If air filter has a dust unloading valve (C), squeeze valve tip to release any trapped dirt particles.
4. Check air intake restriction indicator (D). When indicator is red, air filter needs to be cleaned.

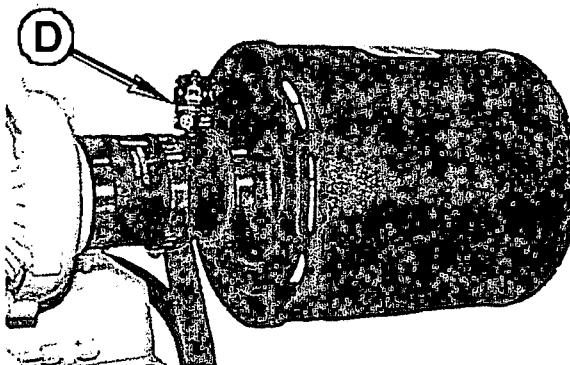
**IMPORTANT:** Maximum air intake restriction is 6.25 kPa (0.06 bar; 1.0 psi) (25 in. H<sub>2</sub>O). A clogged air cleaner element will cause excessive intake restriction and a reduced air supply to the engine.

5. Make a thorough inspection of the engine compartment.

**NOTE:** Wipe all fittings, caps and plugs before performing any maintenance to reduce the chance of system contamination.



RG-4687 -UN-20DEC88



CD30757 -UN-26AUG99

DPSG,CD03523,27 -19-12JUL99-3/3

## Maintenance/500 hours

### CHANGING ENGINE OIL AND FILTER

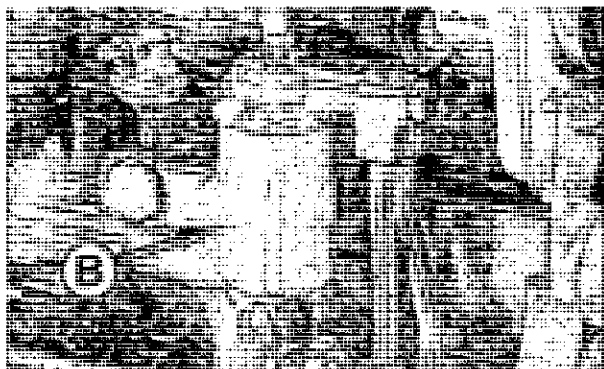
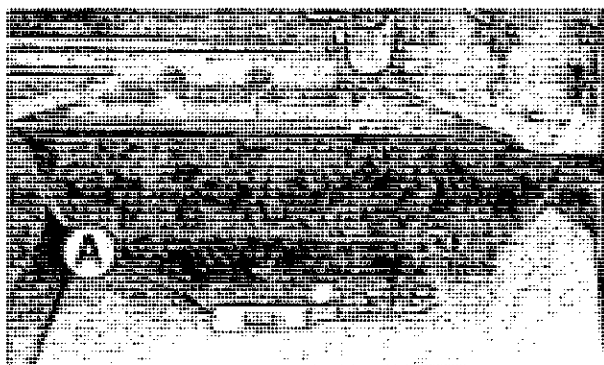
**NOTE:** Change engine oil and filter for the first time after 100 hours maximum of operation, then every 500 hours thereafter. Change oil and filter at least once a year.

1. Run engine approximately 5 minutes to warm up oil. Shut engine off.
2. Open oil pan drain valve (A).
3. Drain crankcase oil from engine while warm.
4. Remove and discard oil filter element (B) using a suitable filter wrench.

Remove oil filter packing and clean filter mounting pad.

**IMPORTANT:** Filtration of oils is critical to proper lubrication. Always change filter regularly. Use filters meeting John Deere performance specifications.

6. Oil the new packing and install a new filter element. Hand tighten element according to values printed on filter element. If values are not provided, tighten element approximately 3/4 — 1-1/4 turn after packing contacts filter housing. DO NOT overtighten filter element.
7. Close oil pan drain valve.



POWERTEch engine



300-Series engine

Continued on next page

DPSG,CD03523,29 -19-12JUL99-1/2

## Maintenance/500 hours

8. Fill engine crankcase with correct John Deere engine oil through rocker arm cover opening (C); see DIESEL ENGINE OIL.

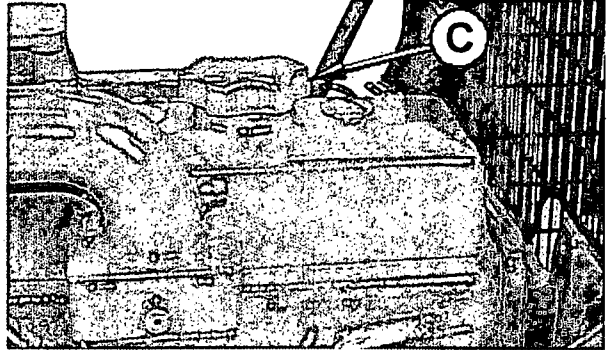
To determine the correct oil fill quantity for your engine, see "Engine Oil Quantities" in Specifications Section.

**NOTE:** Crankcase oil capacity may vary slightly. ALWAYS fill crankcase to full mark or within crosshatch on dipstick, whichever is present. DO NOT overfill.

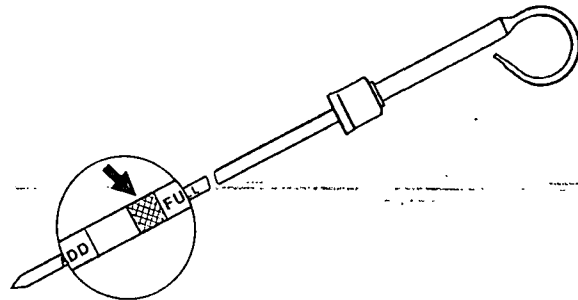
**IMPORTANT:** Immediately after completing any oil change, crank engine for 30 seconds without permitting engine to start. This will help insure adequate lubrication to engine components before engine starts.

9. Start engine and run to check for possible leaks.

10. Stop engine and check oil level after 10 minutes. If necessary, top up.



CD30761 -UN-24SEP99



FD000047

FD000047 -UN-13MAR96

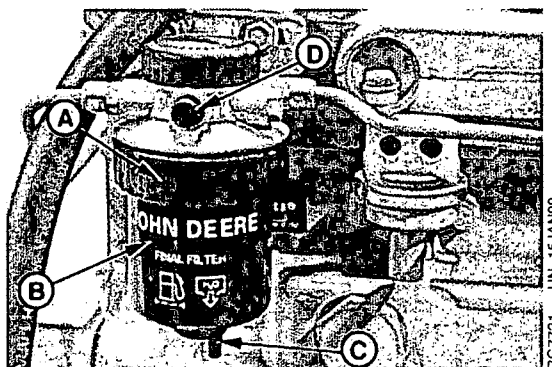
DPSG,CD03523,29 -19-12JUL99-2/2

Maintenance/500 hours

## REPLACING FUEL FILTER ELEMENT



X9811 -JN-23AUG88



RG7721 -JN-15JAN99

A—Retaining ring

B—Filter element

C—Drain plug

D—Bleed plug



**CAUTION: CAUTION:** Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.

If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

1. Thoroughly clean fuel filter assembly and surrounding area.
2. Loosen drain plug (C) and drain fuel into a suitable container.

**NOTE:** Lifting up on retaining ring as it is rotated helps to get it past raised locators.

3. Firmly grasp the retaining ring (A) and rotate it clockwise 1/4 turn. Remove ring with filter element (B).

**IMPORTANT:** Do not dump the old fuel into the new filter element. This could cause fuel injection problem.

A plug is provided with the new element for plugging the used element.

4. Inspect filter mounting base for cleanliness. Clean as required.

**NOTE:** Raised locators on fuel filter canister must be indexed properly with slots in mounting base for correct installation.

5. Install new filter element dry onto mounting base. Be sure element is properly indexed and firmly seated on base. It may be necessary to rotate filter for correct alignment.

6. Install retaining ring onto mounting base making certain dust seal is in place on filter base. Hand tighten ring (about 1/3 turn) until it "snaps" into the detent. DO NOT overtighten retaining ring.

**NOTE:** The proper installation is indicated when a "click" is heard and a release of the retaining ring is felt.

7. Bleed the fuel system.

DPSG.C003523,30 -19-12JUL99-1/1

30-3

112600  
PN=49

## Maintenance/500 hours

**CHECKING BELT (300-SERIES ENGINES)**

1. Inspect belt for cracks, fraying, or stretched out areas. Replace as necessary.
2. Check belt tension using one of following methods:

**a) Use of JDG529 Tension Gauge (A)****Belt tension—Specification**

|                 |                              |
|-----------------|------------------------------|
| New belt.....   | 578—622 N (130—140 lb-force) |
| Used belt ..... | 378—423 N (85—94 lb-force)   |

**NOTE:** Belt is considered used after 10 minutes of operation.

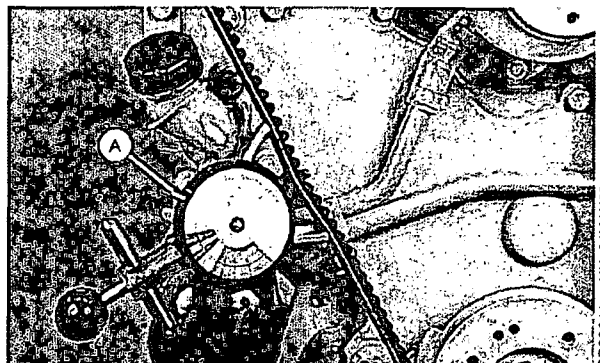
**b) Use of tension tester (B) and straight edge (C)**

A 89 N (20 lb) force applied halfway between pulleys should deflect belt by 19 mm (0.75 in.).

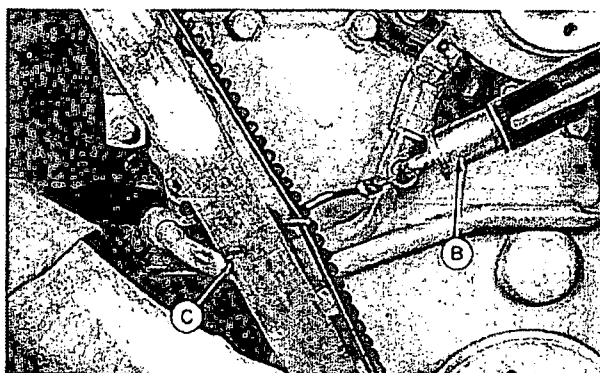
3. If adjustment is necessary, loosen alternator nuts (D) and (E). Pull alternator frame outward until belt is correctly tensioned.

**IMPORTANT:** Do not pry against the alternator rear frame. Do not tighten or loosen belts while they are hot.

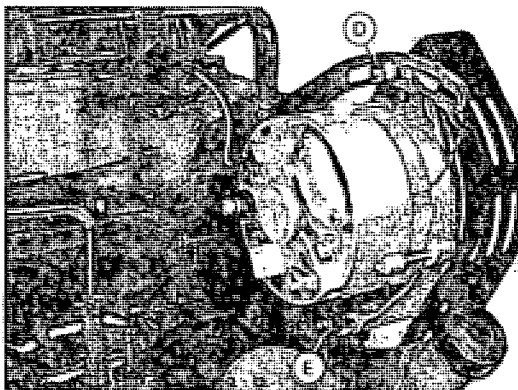
4. Tighten alternator bracket nuts firmly.
5. Run engine for 10 minutes then recheck belt tension.



CD30644 -UN-04MAY98



CD30645 -UN-04MAY98



CD30646 -UN-04MAY98

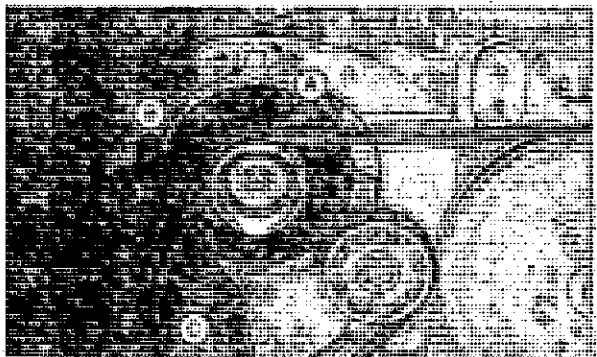
DPSG.CD03523.31 -19-12JUL99-1/1

## Maintenance/500 hours

**CHECKING BELT (POWERTECH ENGINES WITH MANUAL TENSIONER)**

Inspect belt for cracks, fraying, or stretched out areas. Replace if necessary.

**NOTE:** Belt adjustment is measured using a gauge stamped on the top edge of the alternator bracket.



1. Loosen cap screws (B) and (C).
2. Slide alternator in slot by hand to remove all excess slack in belt.

**IMPORTANT:** Do not pry against alternator rear frame.

3. Using the gauge (A) on the alternator bracket, stretch belt by prying outward on alternator front frame. Stretch the belt 1 gauge unit for a used belt and 1.5 gauge units for a new belt.

4. Tighten cap screws (B) and (C).

A—Belt gauge  
B—Cap screw  
C—Cap screw

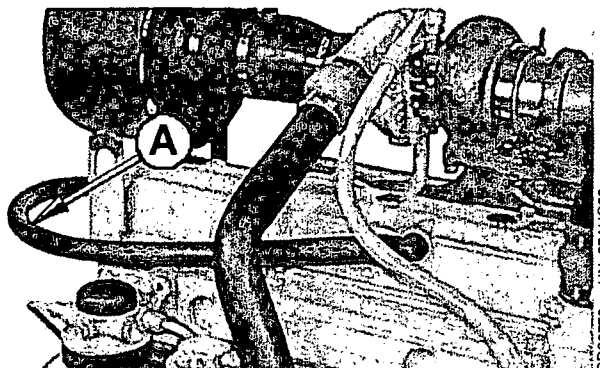
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## Maintenance/1000 hours/1 year

### CLEANING CRANKCASE VENT TUBE

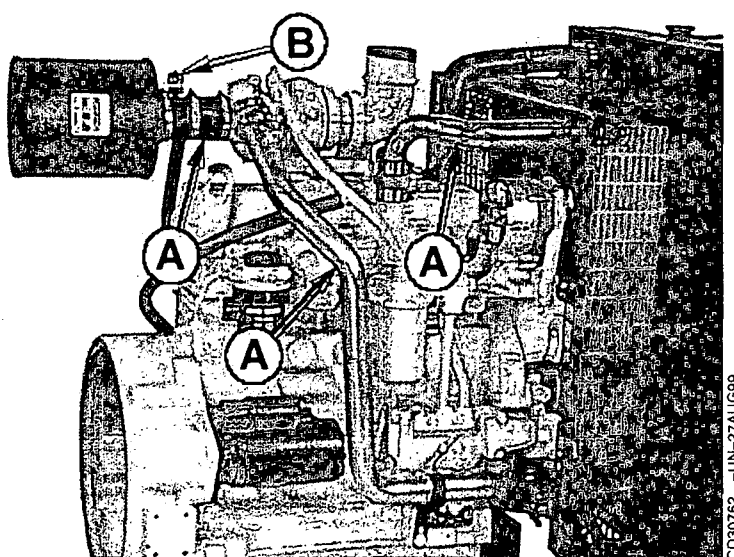
If you operate the engine in dusty conditions, clean the tube at shorter intervals.

1. Remove and clean crankcase vent tube (A).
2. Install the vent tube. Be sure the O-ring fits correctly in the rocker arm cover bore for elbow adapter. Tighten hose clamp securely.



DPSG,CD03523,32 -19-12JUL99-1/1

### CHECKING AIR INTAKE SYSTEM



**IMPORTANT:** The air intake system must not leak. Any leak, no matter how small, may result in engine failure due to abrasive dirt and dust entering the intake system.

1. Inspect all intake hoses (piping) for cracks. Replace as necessary.
2. Check clamps on piping (A) which connect the air filter, engine and, if present, turbocharger and air-to-air radiator. Tighten clamps as necessary.
3. Test air restriction indicator (B) for proper operation. Replace indicator as necessary.

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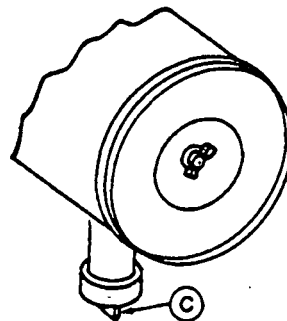
DPSG,CD03523,33 -19-12JUL99-1/2

35-1

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PN=52

## Maintenance/1000 hours/1 year

4. If engine has a rubber dust unloading valve (C), inspect the valve on bottom of air filter for cracks or plugging. Replace as necessary.
5. Service air filter as necessary.



RG4687 -UN-20DEC88

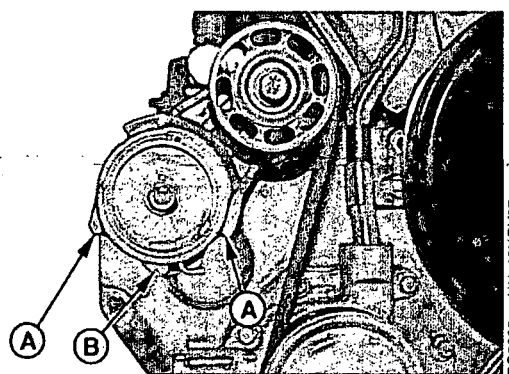
DPSG,CD03523,33 -19-12JUL99-2/2

### CHECKING AUTOMATIC BELT TENSIONER (POWERTECH ENGINES)

It drive systems equipped with automatic (spring) belt tensioners cannot be adjusted or repaired. The automatic belt tensioner is designed to maintain proper belt tension over the life of the belt. If tensioner spring tension is not within specification, replace tensioner assembly.

- **Checking belt wear**

The belt tensioner is designed to operate within the limit of arm movement provided by the cast stops (A) and (B) when correct belt length and geometry is used. If the tensioner stop on swing arm (A) is hitting the fixed stop (B), check mounting brackets (alternator, belt tensioner, idler pulley, etc.) and the belt length. Replace belt as needed (see REPLACING FAN AND ALTERNATOR BELTS).



RG8038 -UN-18NOV97

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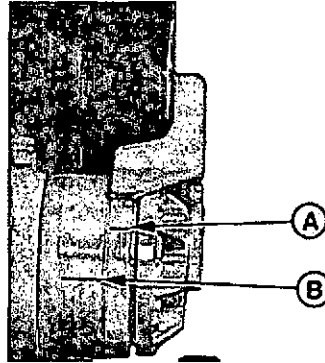
DPSG,CD03523,34 -19-13JUL99-1/2

## Maintenance/1000 hours/1 year

### • Checking tensioner spring tension

A belt tension gauge will not give an accurate measure of the belt tension when automatic spring tensioner is used. Measure tensioner spring tension using a torque wrench and procedure outlined below:

- Release tension on belt using a breaker bar and socket on tension arm. Remove belt from pulleys.
- Release tension on tension arm and remove breaker bar.
- Put a mark (A) on swing arm of tensioner as shown.
- Measure 21 mm (0.83 in.) from (A) and put a mark (B) on tensioner mounting base.
- Rotate the swing arm using a torque wrench until marks (A) and (B) are aligned.
- Record torque wrench measurement and compare with specification below. Replace tensioner assembly as required.



RG7977 -UN-14NOV97

#### Spring—Specification

Force..... 18—22 N•m (13—16 lb-ft)

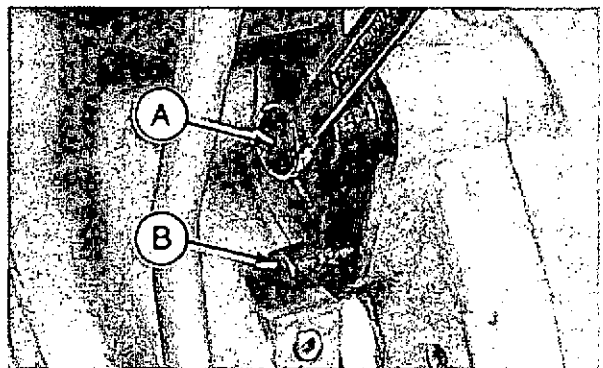
DPSG,CD03523,34 -19-13JUL99-2/2

### CHECK AND ADJUST ENGINE VALVE CLEARANCE (300-SERIES ENGINES)

**NOTE:** Valve clearance must be adjusted after the first 500 hours of operation, then every 1000 hours thereafter.

Adjust engine valve clearance as follows or have your authorized servicing dealer or engine distributor adjust the engine valve clearance.

- Remove rocker arm cover and crankcase vent tube.
- Using JDE83 or JDG820 Flywheel Turning Tool (A), rotate engine flywheel in running direction (clockwise viewed from water pump) until No.1 piston (front) has reached top dead center (TDC) on compression stroke. Insert timing pin JDE81-4 (B) into flywheel bore.



CD30544 -UN-19MAY98

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DPSG,CD03523,35 -19-13JUL99-1/4

35-3

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PN=54

## Maintenance/1000 hours/1 year

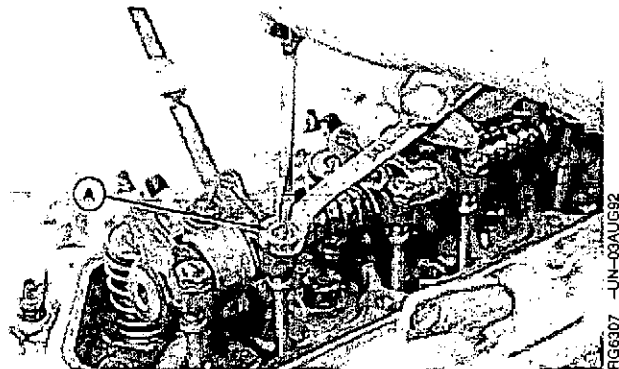
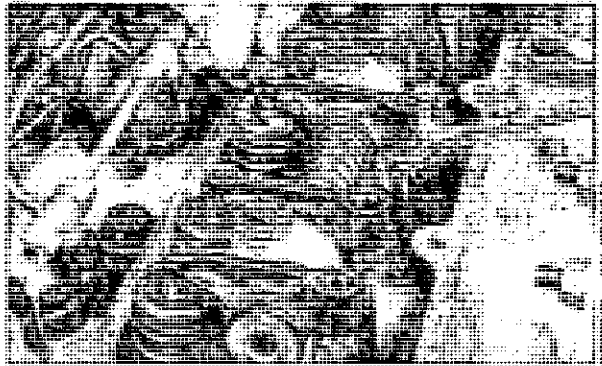
3. Check and adjust valve clearance to specifications according to following procedures.

Valve clearance (engine cold)—Specification

|              |                     |
|--------------|---------------------|
| Intake.....  | 0.35 mm (0.014 in.) |
| Exhaust..... | 0.45 mm (0.018 in.) |

**NOTE:** If rocker arm is equipped with adjusting screw and lock nut (A), tighten lock nut to 27 N·m (20 lb-ft) after adjusting valve clearance.

4. Reinstall rocker arm cover and crankcase vent tube.

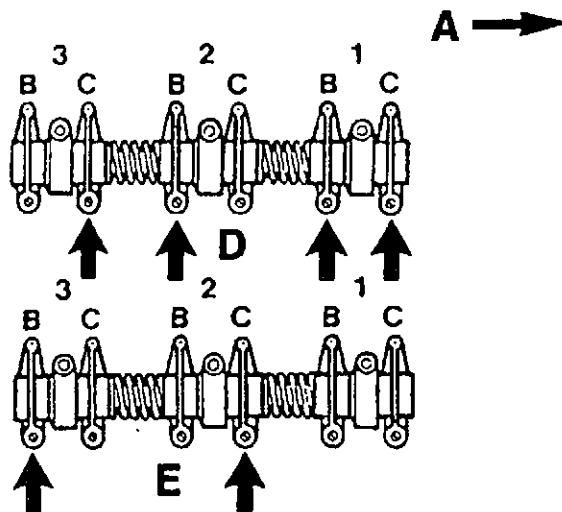


DPSG,CD03523,35 -19-13JUL99-2/4

• 3-Cylinder Engine:

**NOTE:** Firing order is 1-2-3.

- Lock No. 1 piston at TDC compression stroke (D).
- Adjust valve clearance on No. 1 and 2 exhaust valves and No.1 and 3 intake valves.
- Rotate flywheel 360°. Lock No. 1 piston at TDC exhaust stroke (E).
- Adjust valve clearance on No. 3 exhaust valve and No. 2 intake valve.



A—Front of engine  
B—Exhaust valve  
C—Intake valve  
D—No.1 Piston at TDC compression stroke  
E—No.1 Piston at TDC exhaust stroke

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DPSG,CD03523,35 -19-13JUL99-3/4

35-4

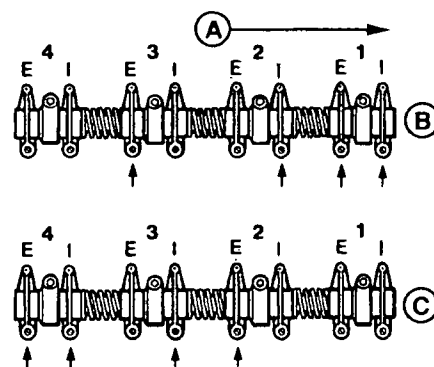
112890  
PN=55

## Maintenance/1000 hours/1 year

## • 4-Cylinder Engine:

NOTE: Firing order is 1-3-4-2.

- Lock No. 1 piston at TDC compression stroke (B).
- Adjust valve clearance on No. 1 and 3 exhaust valves and No.1 and 2 intake valves.
- Rotate flywheel 360°. Lock No. 4 piston at TDC compression stroke (C).
- Adjust valve clearance on No. 2 and 4 exhaust valves and No. 3 and 4 intake valves.



A—Front of engine  
 B—No.1 Piston at TDC compression stroke  
 C—No.4 Piston at TDC compression stroke  
 E—Exhaust valve  
 I—Intake valve

RG4776 -UN-31OCT97

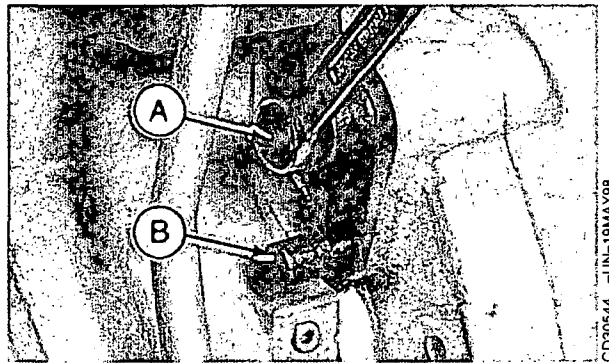
DPSG,CD03523,35 -19-13JUL99-4/4

# Maintenance/2000 hours/2 years

## CHECK AND ADJUST ENGINE VALVE CLEARANCE (POWERTECH ENGINE)

Adjust engine valve clearance as follows or have your authorized servicing dealer or engine distributor adjust the engine valve clearance.

1. Remove rocker arm cover and crankcase vent tube.
2. Using JDE83 or JDG820 Flywheel Turning Tool (A), rotate engine flywheel in running direction (clockwise viewed from water pump) until No.1 piston (front) has reached top dead center (TDC) on compression stroke. Insert timing pin JDE81-4 (B) into flywheel bore.



CD30544 -UN-19MA198

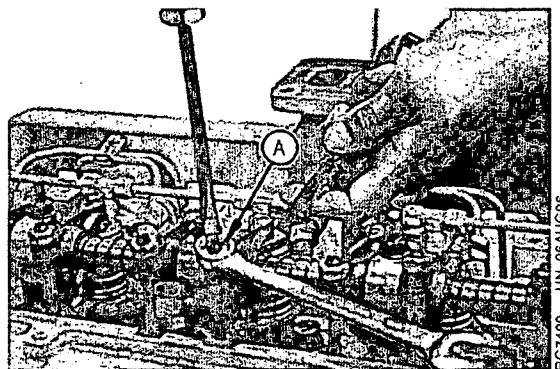
DPSG.CD03523.36 -19-13JUL99-1/4

3. Check and adjust valve clearance to specifications according to following procedures.

### Valve clearance (engine cold)—Specification

|              |                     |
|--------------|---------------------|
| Intake.....  | 0.35 mm (0.014 in.) |
| Exhaust..... | 0.45 mm (0.018 in.) |

4. If valves need adjusting, loosen the lock nut on rocker arm adjusting screw. Turn adjusting screw until feeler gauge slips with a slight drag. Hold the adjusting screw from turning with screwdriver and tighten lock nut to 27 N•m (20 lb-ft). Recheck clearance again after tightening lock nut. Readjust clearance as necessary.
5. Reinstall rocker arm cover and crankcase vent tube.



FG7409 -UN-06AUG96

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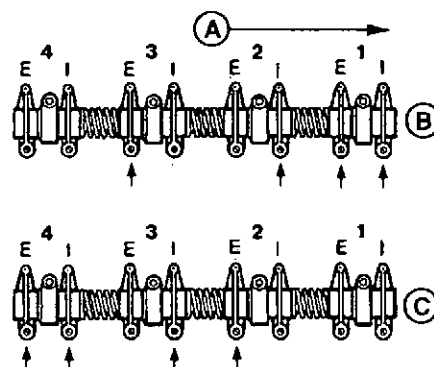
DPSG.CD03523.36 -19-13JUL99-2/4

## Maintenance/2000 hours/2 years

## • 4-Cylinder Engine:

NOTE: Firing order is 1-3-4-2.

- Lock No. 1 piston at TDC compression stroke (B).
- Adjust valve clearance on No. 1 and 3 exhaust valves and No. 1 and 2 intake valves.
- Rotate flywheel 360°. Lock No. 4 piston at TDC compression stroke (C).
- Adjust valve clearance on No. 2 and 4 exhaust valves and No. 3 and 4 intake valves.



A—Front of engine  
 B—No.1 Piston at TDC compression stroke  
 C—No.4 Piston at TDC compression stroke  
 E—Exhaust valve  
 I—Intake valve

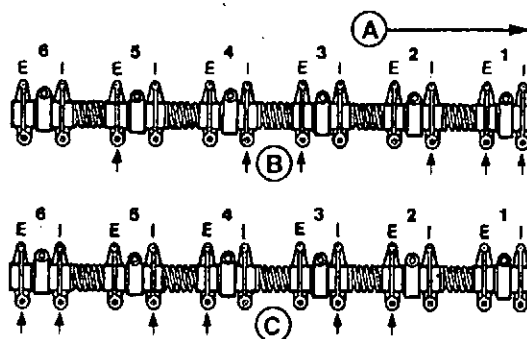
RG4776 -UN-31OCT97

DPSG,CD03523,36 -19-13JUL99-3/4

## • 6-Cylinder Engine:

NOTE: Firing order is 1-5-3-6-2-4.

- Lock No. 1 piston at TDC compression stroke (B).
- Adjust valve clearance on No. 1, 3, and 5 exhaust valves and No. 1, 2, and 4 intake valves.
- Rotate flywheel 360°. Lock No. 6 piston at TDC compression stroke (C).
- Adjust valve clearance on No. 2, 4, and 6 exhaust valves and No. 3, 5, and 6 intake valves.



A—Front of engine  
 B—No.1 Piston at TDC compression stroke  
 C—No.6 Piston at TDC compression stroke  
 E—Exhaust valve  
 I—Intake valve

RG4777 -UN-31OCT97

DPSG,CD03523,36 -19-13JUL99-4/4

Maintenance/2000 hours/2 years

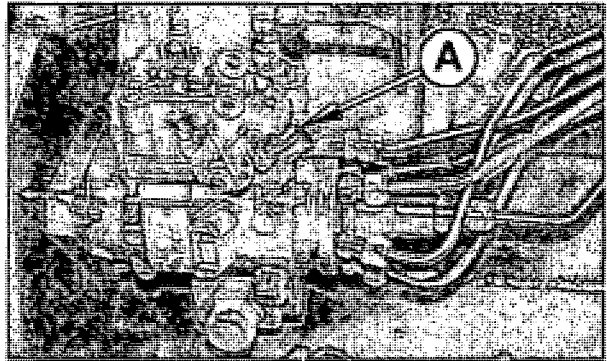
**CHECKING ENGINE SPEED**

**NOTE:** Most engines for generator set application (1500 rpm for 50 Hz or 1800 rpm for 60 Hz) run only at fast idle and therefore they do not have slow idle.

**Fast idle—Specification**

|                          |               |
|--------------------------|---------------|
| 50 Hz Generator set..... | 1550—1580 rpm |
| 60 Hz Generator set..... | 1865—1890 rpm |

**NOTE:** Fast idle is settled by the factory then the idle adjusting screw (A) is sealed to prevent from tampering. Fast idle adjustment can only be done by an authorized fuel system agent.

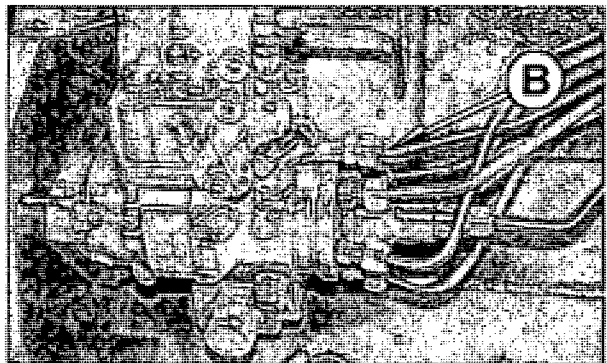


DPSG.CD03523.38 -19-13JUL99-1/1

**ADJUST SPEED DROOP GOVERNOR**

1. Warm engine to normal operating temperature.
2. Run engine at fast idle.
3. Apply full load.
4. If specified power cannot be obtained, turn screw (B) to adjust droop until the requested power is reached.

**NOTE:** If surging exists upon removing the load, turn screw (B) clockwise to eliminate.



DPSG.CD03523.39 -19-13JUL99-1/1

Maintenance/2000 hours/2 years

**CHECKING CRANKSHAFT VIBRATION DAMPER (6-CYLINDER ENGINE ONLY)**

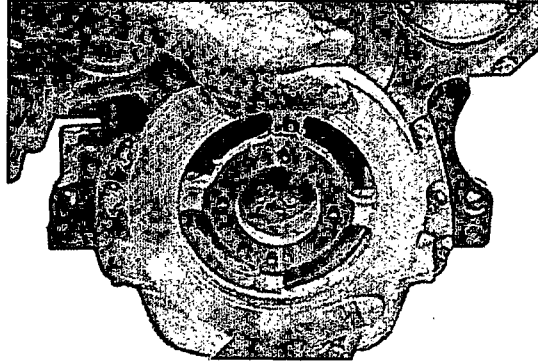
1. Remove belts (shown removed).
2. Grasp vibration damper with both hands and attempt to turn it in both directions. If rotation is felt, damper is defective and should be replaced.

**IMPORTANT:** The vibration damper assembly is not repairable and should be replaced every 4500 hours or 5 years, whichever occurs first.

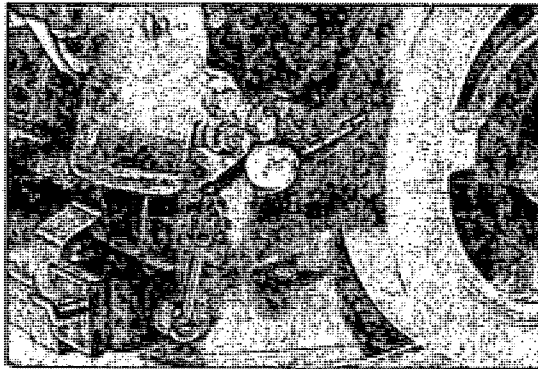
3. Check vibration damper radial runout by positioning a dial indicator so probe contacts damper outer circumference.
4. With engine at operating temperature, rotate crankshaft using JDG820 or JDE83 Flywheel Turning Tool.
5. Note dial indicator reading. If runout exceeds specifications given below, replace vibration damper.

**Damper—Specification**

Maximum radial runout..... 1.50 mm (0.060 in.)



RG8018 -UN-15JAN99



RG7508 -UN-23NOV97

DPSG,CD03523,40 -19-13JUL99-1/1

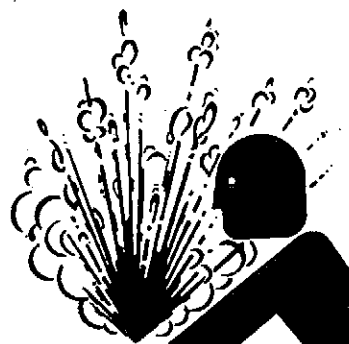
# Maintenance/2500 hours/3 years

## DRAIN AND FLUSH COOLING SYSTEM

**NOTE:** Drain and flush cooling system every 2500 hours/3 years when John Deere COOL-GARD coolant is used. Otherwise every 2000 hours/2 years.

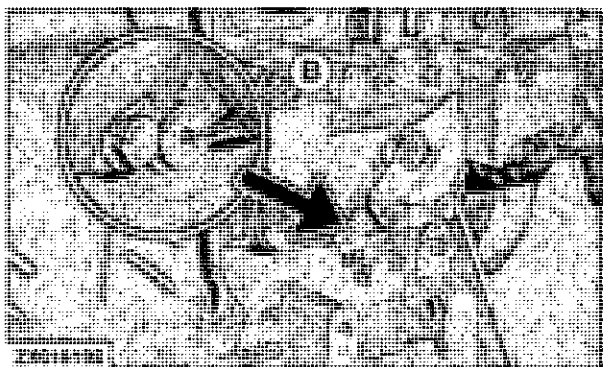
**CAUTION:** Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

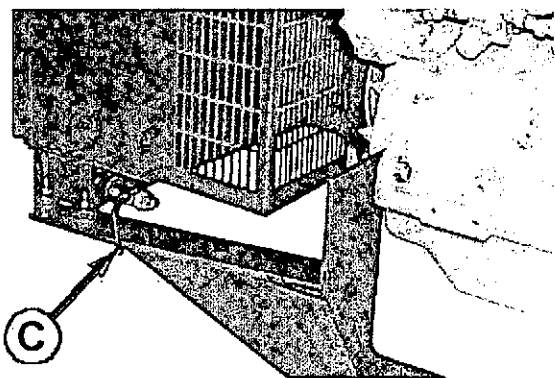


TS281 -UN-23AUG88

1. Slowly open the radiator cap.
2. Remove engine block drain plug (A).
3. On POWERTech engines, remove oil cooler housing drain plug (B).
4. Open radiator drain valve (C). Drain all coolant from radiator.
5. Close all drain orifices after coolant has drained.
6. Fill the cooling system with clean water. Run engine until water passes through the thermostat to stir up possible rust or sediment.
7. Stop engine and immediately drain the water from system before rust and sediment settle.
8. After draining water, close all drain orifices and fill the cooling system with clean water and TY15979 John Deere Heavy Duty Cooling System Cleaner or equivalent cleaner. Follow manufacturer's directions on label.
9. After cleaning the cooling system, drain cleaner and fill with water to flush the system. Run engine until water passes through the thermostat, then drain out flushing water.



ZX016192 -UN-11JAN99



CD30763 -UN-27AUG99

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DPSG,CD03523,41 -19-13JUL99-1/3

*Maintenance/2500 hours/3 years*

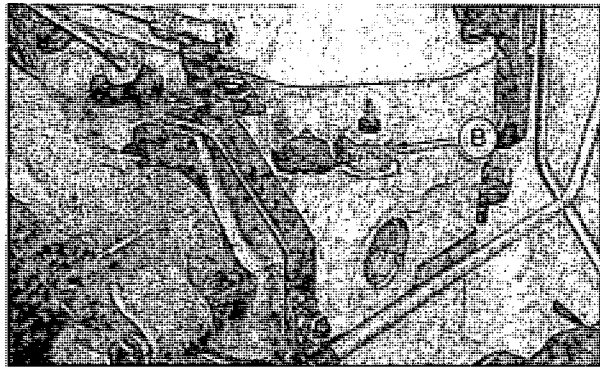
10. Check cooling system hoses for proper condition.  
Replace as necessary.
11. Close all drain orifices and fill the cooling system with  
specified coolant (see DIESEL ENGINE COOLANT).

**Cooling system capacity—Specification**

|                  |                  |
|------------------|------------------|
| CD3029DF128..... | 14.5 L (15.5 qt) |
| CD4039DF008..... | 16.5 L (17.5 qt) |
| CD4039TF008..... | 16.5 L (17.5 qt) |
| CD4045DF158..... | 20 L (21 qt)     |
| CD4045HF158..... | 25 L (26.5 qt)   |
| CD4045TF158..... | 25 L (26.5 qt)   |
| CD4045TF258..... | 25 L (26.5 qt)   |
| CD6068HF158..... | 29 L (30.5 qt)   |
| CD6068TF158..... | 26 L (27.5 qt)   |
| CD6068TF258..... | 26 L (27.5 qt)   |

DPSG.CD03523.41 -19-13JUL99-2/3

12. When refilling cooling system, loosen temperature  
sensor (B) or plug at the rear of cylinder head to  
allow air to escape.
13. Run engine until it reaches operating temperature  
then check coolant level and entire cooling system for  
leaks.



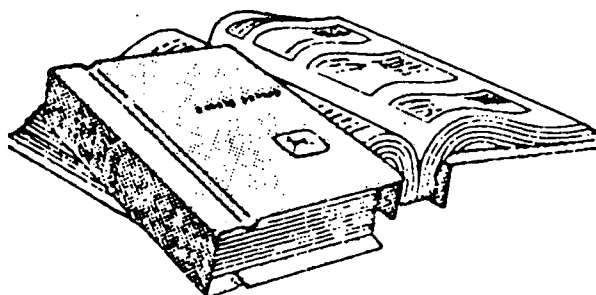
DPSG.CD03523.41 -19-13JUL99-3/3

# Maintenance/As required

## ADDITIONAL SERVICE INFORMATION

This manual does not allow a complete repair of your engine. If you want more detailed service information the following publications are available from your regular parts channel.

- PC2451 — Parts Catalog
- CTM3274 — Component Technical Manual for 300-Series engines (English)
- CTM104 — Component Technical Manual for POWERTech engines (English)
- CTM67 — Component Technical Manual for OEM Engine accessories (English only)
- CTM77 — Component Technical Manual for Alternators and Starter Motors (English only)



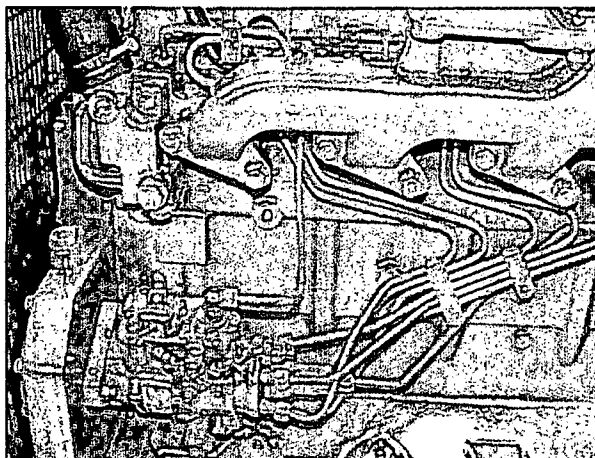
RG4624 -UN-15DEC88

DPSG.CD03523.42 -19-15JUL99-1/1

## DO NOT MODIFY FUEL SYSTEM

**IMPORTANT:** Modification or alteration of the injection pump, the injection pump timing, or the fuel injectors in ways not recommended by the manufacturer will terminate the warranty obligation to the purchaser.

Do not attempt to service injection pump or fuel injectors yourself. Special training and special tools are required (see your authorized servicing dealer or engine distributor).



CD30768 -UN-24SEP89

DPSG.CD03523.43 -19-15JUL99-1/1

Maintenance/As required

**CLEAN OR REPLACE AIR FILTER  
(ONE-PIECE)**

Clean air filter when restriction indicator (A) is red. Air filter can be cleaned up to six times. Thereafter, or at least once a year, it must be replaced.

Proceed as follows:

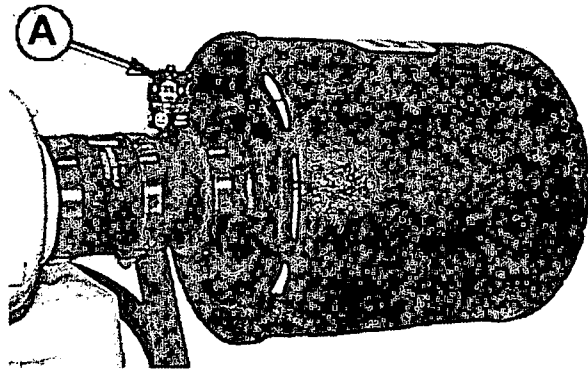
1. Thoroughly clean all dirt around air filter area.
2. Loosen clamp (B) then remove air filter.

**IMPORTANT:** Never reinstall an air filter which shows evidence of bad condition (punched, dented...) allowing no filtered air to enter the engine.

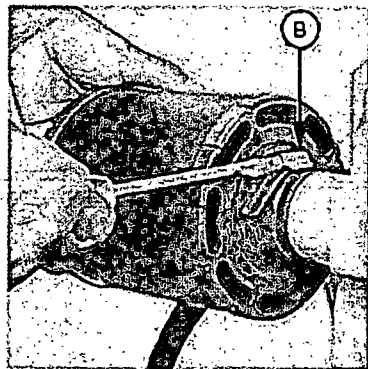
3. Clean air filter with compressed air working from "clean" to "dirty" side.

**NOTE:** Compressed air must not exceed 600 kPa (6 bar; 88 psi).

4. Mark air filter to keep track of each cleaning operation.
5. Fully depress air restriction indicator reset button and release to reset indicator.
6. Check air system entirely for proper condition (see CHECKING AIR INTAKE SYSTEM).



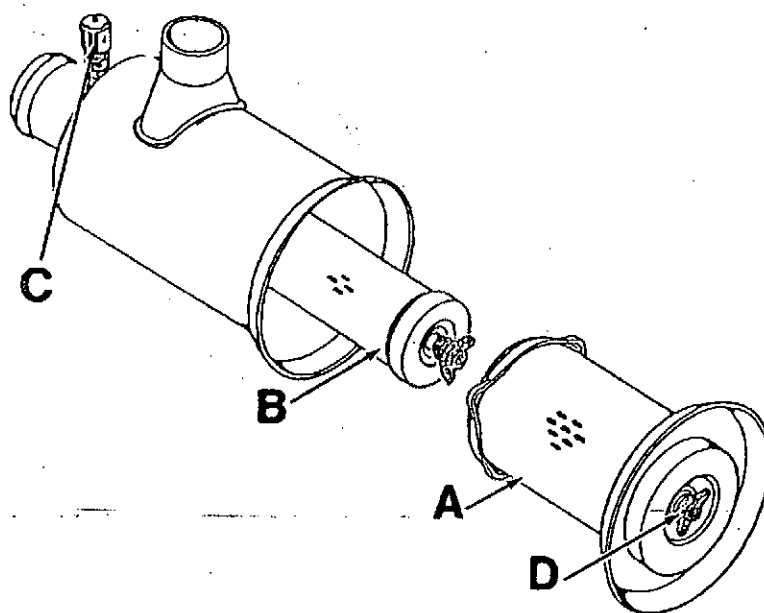
CD30766 -UN-06SEP99



RG9912 -UN-25FEB99

DPSG,CD03523.44 -19-15JUL99-1/1

Maintenance/As required

**CLEAN OR REPLACE AIR FILTER ELEMENT**

A—Primary element  
B—Secondary (safety)  
element

C—Air restriction indicator  
D—Wing nut

Clean air filter when restriction indicator (C) is red. Replace both primary (A) and secondary (B) filter elements every 6 primary element cleaning or at least once a year.

**dented...), replace both the primary and the secondary elements.**

Proceed as follows:

1. Thoroughly clean all dirt around air filter area.
2. Remove wing nut (D) and remove primary element (A) from canister.

**IMPORTANT:** Do not attempt to clean the secondary (safety) element (B). It must be only replaced as recommended.

3. Thoroughly clean all dirt from inside canister.

**IMPORTANT:** If primary element shows evidence of bad condition (punched,

4. Clean primary element with compressed air working from "clean" to "dirty" side.

**NOTE:** Compressed air must not exceed 600 kPa (6 bar; 88 psi).

5. Mark air filter to keep track of each cleaning operation.
6. Fully depress air restriction indicator reset button and release to reset indicator.
7. Check air system entirely for proper condition (see CHECKING AIR INTAKE SYSTEM).

CD30772 -JUN-27AUG99

DPSG,CD03523,58 -19-16AUG99-1/1

50-3

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Maintenance/As required

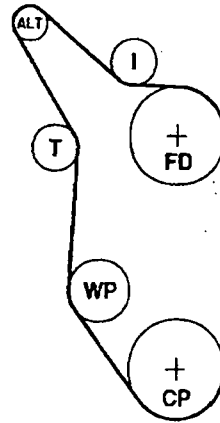
## REPLACING FAN AND ALTERNATOR BELT (POWERTECH ENGINES)

**NOTE:** Refer to *CHECKING BELT TENSIONER SPRING TENSION AND BELT WEAR* for additional information on the belt tensioner.

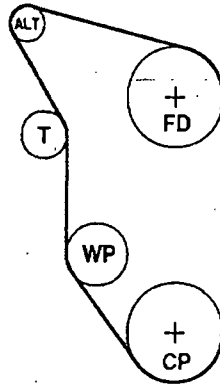
1. Inspect belts for cracks, fraying, or stretched out areas. Replace if necessary.
2. On engines with automatic belt tensioner, release tension on belt using a breaker bar and socket on tension arm.

On engines with manual tensioner, loosen cap screws holding the alternator.

3. Remove poly-vee belt from pulleys and discard belt.
4. Install new belt, making sure belt is correctly seated in all pulley grooves. Refer to belt routing at right for your application.
5. Apply tension to belt (see *CHECKING BELT*).
6. Start engine and check belt alignment.



Installation on 4 cyl. engines



Installation on 6 cyl. engines

ALT—Alternator  
CP—Crankshaft Pulley  
FD—Fan Drive  
I—Idler Pulley  
T—Tensioner  
WP—Water Pump

CD030769 -UN-01SEP99

CD030770 -UN-01SEP99

DPSG,CD03523.45 -19-15JUL99-1/1

Maintenance/As required

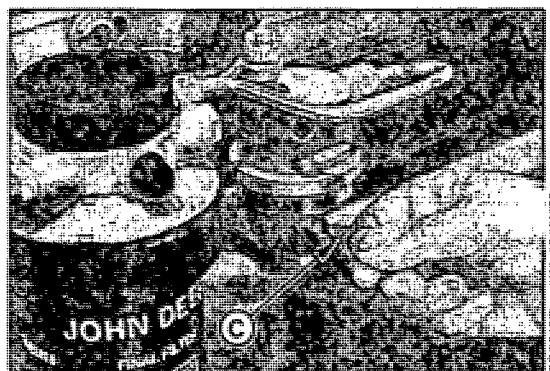
## CHECKING FUEL FILTER

Periodically the fuel filter should be checked for water or debris.

**IMPORTANT: Drain water into a suitable container and dispose of properly.**

1. Loosen drain plug (B) at bottom of fuel filter two or three turns.
2. Loosen air bleed plug two full turns (A) on fuel filter base and drain water from bottom until fuel starts to drain out.
3. When fuel starts to drain out, tighten drain plug securely.
4. After draining water from the fuel filter, the filter must be primed by bleeding all air from the fuel system: Operate primer lever of the fuel supply pump (C) until fuel flow is free from air bubbles.
5. Tighten bleed plug securely, continue operating hand primer until pumping action is not felt. Push hand primer inward (toward engine) as far as it will go.

If the fuel system needs further bleeding of air, see **BLEEDING THE FUEL SYSTEM**.

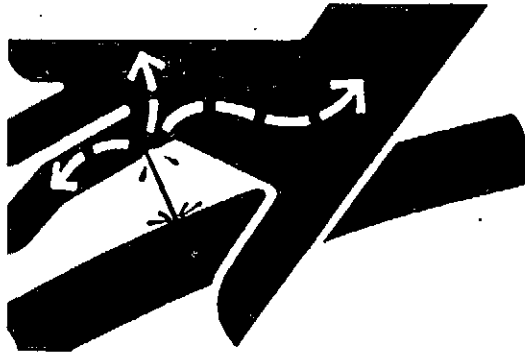


DPSG.CD03523.28 -19-12JUL99-1/1

Maintenance/As required

**BLEEDING THE FUEL SYSTEM**

**CAUTION:** Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure. Use a piece of cardboard or paper to search for leaks. Do not use your hand.



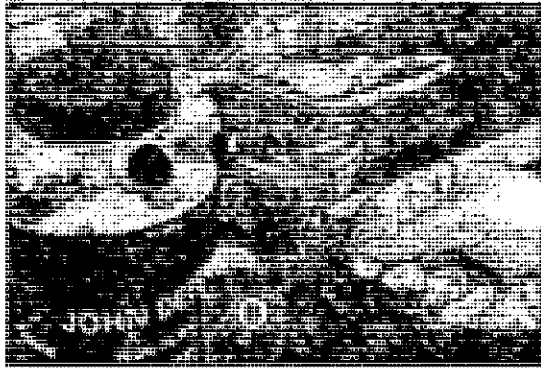
X9811 -UN-23AUG88

If ANY fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result. Doctors unfamiliar with this type of injury may call the Deere & Company Medical Department in Moline, Illinois, or other knowledgeable medical source.

Whenever the fuel system has been opened up for service (lines disconnected or filters removed), it will be necessary to bleed air from the system.

1. Loosen the air bleed screw (A) two full turns by hand on fuel filter base.
2. Operate supply pump primer lever (B) until fuel flow is free from air bubbles.
3. Tighten bleed plug securely, continue operating hand primer until pumping action is not felt. Push hand primer inward (toward engine) as far as it will go.
4. Start engine and check for leaks.

If engine will not start, it may be necessary to bleed air from fuel system at fuel injection pump or injection nozzles as explained next.



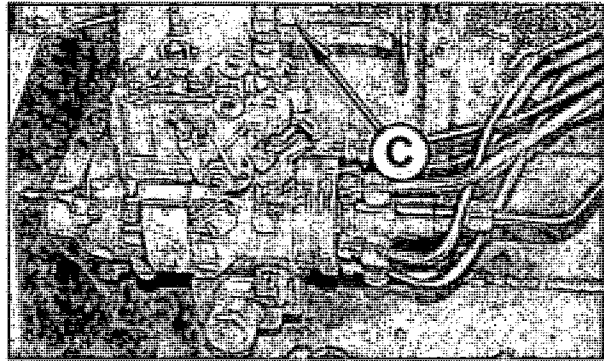
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DPSG.CD03523.46 -19-10AUG99-1/2

*Maintenance/As required*

- **At Fuel Injection Pump:**

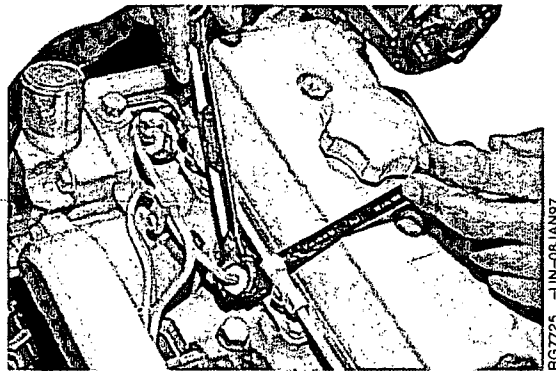
- Slightly loosen fuel return line connector (C) at fuel injection pump.
- Operate fuel supply pump primer lever until fuel, without air bubbles, flows from fuel return line connection.
- Tighten return line connector to 16 N•m (12 lb-ft).
- Leave hand primer in the inward position toward cylinder block.



CD30771 -UN-24SEP99

- **At Fuel Injection Nozzles:**

- Using two open-end wrenches, loosen fuel line connection at injection nozzle.
- Crank engine over with starting motor (but do not start engine), until fuel free from bubbles flows out of loosened connection. Retighten connection to 27 N•m (20 lb-ft).
- Repeat procedure for remaining injection nozzles (if necessary) until all air has been removed from fuel system.



RG7725 -UN-08JAN97

If engine still will not start, see your authorized servicing dealer or engine distributor.

DPSG.CD03523.46 -19-10AUG99-2/2

# Troubleshooting

## ENGINE TROUBLESHOOTING

| Symptom                                       | Problem  | Solution  |
|---|--|---|
| <b>Engine cranks but will not start</b>       | Incorrect starting procedure.                          | Verify correct starting procedure.                                      |
|   | No fuel.   | Check fuel in tank and manual shut-off valve.                           |
|   | Exhaust restricted.                                    | Check and correct exhaust restriction.                                  |
|   | Fuel filter plugged or full of water.                  | Replace fuel filter or drain water from filter.                         |
|   | Injection pump not getting fuel or air in fuel system. | Check fuel flow at supply pump or bleed fuel system.                    |
|   | Faulty injection pump or nozzles.                      | Consult authorized diesel repair station for repair or replacement.     |
| <b>Engine hard to start or will not start</b> | Engine starting under load.                            | Remove load.  |
|   | Improper starting procedure.                           | Review starting procedure.  |
|   | No fuel.   | Check fuel tank.  |
|   | Air in fuel line.                                      | Bleed fuel line.  |
|   | Cold weather.  | Use cold weather starting aids.   |
|   | Slow starter speed.                                    | See "Starter Cranks Slowly".  |
|   | Crankcase oil too heavy.                               | Use oil of correct viscosity.   |
|   | Improper type of fuel.                                 | Consult fuel supplier; use proper type fuel for operating conditions.   |
|   | Water, dirt or air in fuel system.                     | Drain, flush, fill and bleed system.                                    |
|   | Clogged fuel filter.                                   | Replace filter element.   |
|   | Dirty or faulty injection nozzles.                     | Have authorized servicing dealer or engine distributor check injectors. |

Continued on next page

DPSG,CD03523.49 -19-10AUG99-1/5

55-1

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PN=70

### Troubleshooting

| Symptom   | Problem                                | Solution  |
|---|--|---|
| <b>Engine knocks</b>                                | Injection pump shut-off not reset.     | Turn key switch to "OFF" then to "ON".                                  |
|   | Low engine oil level.                  | Add oil to engine crankcase.  |
|   | Injection pump out of time.            | See your authorized servicing dealer or engine distributor.             |
|   | Low coolant temperature.               | Remove and check thermostat.  |
| <b>Engine runs irregularly or stalls frequently</b> | Engine overheating.                    | See "Engine Overheats".   |
|   | Low coolant temperature.               | Remove and check thermostat.  |
| <b>Below normal engine temperature</b>              | Clogged fuel filter.                   | Replace fuel filter element.  |
|   | Water, dirt or air in fuel system.     | Drain, flush, fill and bleed system.                                    |
|   | Dirty or faulty injection nozzles.     | Have authorized servicing dealer or engine distributor check injectors. |
|   | Defective thermostat.                  | Remove and check thermostat.  |
| <b>Lack of power</b>                                | Defective temperature gauge or sender. | Check gauge, sender and connections.                                    |
|   | Engine overloaded.                     | Reduce load.  |
|   | Intake air restriction.                | Service air cleaner.  |
|   | Clogged fuel filter.                   | Replace filter element.   |
|   | Improper type of fuel.                 | Use proper fuel.  |
|   | Overheated engine.                     | See "Engine Overheats".   |
|   | Below normal engine temperature.       | Remove and check thermostat.  |
|   | Improper valve clearance.              | See your authorized servicing dealer or engine distributor.             |
|   | Dirty or faulty injection nozzles.     | Have authorized servicing dealer or engine distributor check injectors. |

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DPSG.CD03523.49 -19-10AUG99-2/5

### Troubleshooting

| Symptom                         | Problem                          | Solution   |
|---------------------------------|----------------------------------|--|
|                                 | Injection pump out of time.      | See your authorized servicing dealer or engine distributor.        |
|                                 | Turbocharger not functioning.    | See your authorized servicing dealer or engine distributor.        |
|                                 | Leaking exhaust manifold gasket. | See your authorized servicing dealer or engine distributor.        |
|                                 | Defective aneroid control line.  | See your authorized servicing dealer or engine distributor.        |
|                                 | Restricted fuel hose.            | Clean or replace fuel hose.  |
|                                 | Low fast idle speed.             | See your authorized servicing dealer or engine distributor.        |
| <b>Low oil pressure</b>         | Low oil level.                   | Add oil.   |
|                                 | Improper type of oil.            | Drain and fill crankcase with oil of proper viscosity and quality. |
| <b>High oil consumption</b>     | Crankcase oil too light.         | Use oil of correct viscosity.                                      |
|                                 | Oil leaks.                       | Check for leaks in lines, gaskets, and drain plug.                 |
|                                 | Restricted crankcase vent tube.  | Clean vent tube.   |
|                                 | Defective turbocharger.          | See your authorized servicing dealer or engine distributor.        |
| <b>Engine emits white smoke</b> | Improper type of fuel.           | Use proper fuel.   |
|                                 | Low engine temperature.          | Warm up engine to normal operating temperature.                    |
|                                 | Defective thermostat.            | Remove and check thermostat.                                       |
|                                 | Defective injection nozzles.     | See your authorized servicing dealer or engine distributor.        |
|                                 | Engine out of time.              | See your authorized servicing dealer or engine distributor.        |

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### Troubleshooting

| Symptom   | Problem  | Solution  |
|---|--|---|
| <b>Engine emits black or grey exhaust smoke</b> | Improper type of fuel.                               | Use proper fuel.  |
|   | Clogged or dirty air cleaner.                        | Service air cleaner.  |
|   | Engine overloaded.                                   | Reduce load.  |
|   | Injection nozzles dirty.                             | See your authorized servicing dealer or engine distributor.                             |
|   | Engine out of time.                                  | See your authorized servicing dealer or engine distributor.                             |
|   | Turbocharger not functioning.                        | See your authorized servicing dealer or engine distributor.                             |
| <b>Engine overheats</b>                         | Engine overloaded.                                   | Reduce load.  |
|   | Low coolant level.                                   | Fill radiator to proper level, check radiator and hoses for loose connections or leaks. |
|   | Faulty radiator cap.                                 | Have serviceman check.  |
|   | Stretched poly-vee belt or defective belt tensioner. | Check automatic belt tensioner and check belts for stretching. Replace as required.     |
|   | Low engine oil level.                                | Check oil level. Add oil as required.   |
|   | Cooling system needs flushing.                       | Flush cooling system.   |
|   | Defective thermostat.                                | Remove and check thermostat.  |
|   | Defective temperature gauge or sender.               | Check coolant temperature with thermometer and replace, if necessary.                   |
| <b>High fuel consumption</b>                    | Incorrect grade of fuel.                             | Use correct grade of fuel.  |
|   | Improper type of fuel.                               | Use proper type of fuel.  |
|   | Clogged or dirty air cleaner.                        | Service air cleaner.  |

Continued on next page

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**Troubleshooting**

| Symptom | Problem                   | Solution  |
|---------|---------------------------|---|
|         | Engine overloaded.        | Reduce load.  |
|         | Improper valve clearance. | See your authorized servicing dealer or engine distributor. |
|         | Injection nozzles dirty.  | See your authorized servicing dealer or engine distributor. |
|         | Engine out of time.       | See your authorized servicing dealer or engine distributor. |
|         | Defective turbocharger.   | See your authorized servicing dealer or engine distributor. |
|         | Low engine temperature.   | Check thermostat.   |

DPSG,CD03523,49 -19-10AUG99-5/5

## Troubleshooting

### ELECTRICAL TROUBLESHOOTING

| Symptom                            | Problem  | Solution  |
|------------------------------------|--|---|
| <b>Undercharged system</b>         | Excessive electrical load from added accessories.                            | Remove accessories or install higher output alternator.     |
|                                    | Excessive engine idling.   | Increase engine rpm when heavy electrical load is used.     |
|                                    | Poor electrical connections on battery, ground strap, starter or alternator. | Inspect and clean as necessary.                             |
|                                    | Defective battery.   | Test battery.   |
|                                    | Defective alternator.  | Test charging system.                                       |
| <b>Battery uses too much water</b> | Cracked battery case.  | Check for moisture and replace as necessary.                |
|                                    | Defective battery.   | Test battery.   |
|                                    | Battery charging rate too high.  | Test charging system.                                       |
| <b>Battery will not charge</b>     | Loose or corroded connections.   | Clean and tighten connections.                              |
|                                    | Sulfated or worn-out battery.  | See your authorized servicing dealer or engine distributor. |
|                                    | Stretched poly-vee belt or defective belt tensioner.                         | Adjust belt tension or replace belts.                       |
|                                    |  |   |
| <b>Starter will not crank</b>      | Engine under load  | Remove load   |
|                                    | Loose or corroded connections.   | Clean and tighten loose connections.                        |
|                                    | Low battery output voltage.  | See your authorized servicing dealer or engine distributor. |
|                                    | Faulty start circuit relay.  | See your authorized servicing dealer or engine distributor. |
|                                    | Blown fuse.  | Replace fuse.   |

Continued on next page

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*Troubleshooting*

| Symptom                         | Problem                        | Solution  |
|---------------------------------|--------------------------------|---|
| <b>Starter cranks slowly</b>    | Low battery output.            | See your authorized servicing dealer or engine distributor. |
|                                 | Crankcase oil too heavy.       | Use proper viscosity oil.                                   |
|                                 | Loose or corroded connections. | Clean and tighten loose connections.                        |
| <b>Entire electrical system</b> | Faulty battery connection.     | Clean and tighten connections.                              |
|                                 | Sulfated or worn-out battery.  | See your authorized servicing dealer or engine distributor. |
|                                 | Blown fuse.                    | Replace fuse.   |

DPSG,CD03523,50 -19-10AUG99-2/2

# Storage

## ENGINE STORAGE GUIDELINES

1. John Deere engines can be stored outside for up to three (3) months with no long term preparation IF COVERED BY WATERPROOF COVERING.
2. John Deere engines can be stored in a standard overseas shipping container for up to three (3) months with no long term preparation.
3. John Deere engines can be stored inside, warehoused, for up to six (6) months with no long term preparation.
4. John Deere engines expected to be stored more than six (6) months, long term storage preparation

**MUST BE taken.** (See PREPARING ENGINE FOR LONG TERM STORAGE).

5. For John Deere engines not yet installed in machines, run a line from a container of AR41937 Nucle Oil (from AR41785 Engine Storage Kit) to the fuel transfer pump intake, and another line from the fuel return manifold to the tank, so that Nucle Oil is circulated through the injection system during cranking.

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## USE AR41785 ENGINE STORAGE KIT

See your John Deere servicing dealer or engine distributor for an AR41785 Engine Storage Kit. Closely follow instructions provided with this kit.

**IMPORTANT:** Inhibitors can easily change to gas. Seal or tape each opening immediately after adding inhibitor.



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## Storage

### PREPARING ENGINE FOR LONG TERM STORAGE

The following storage preparations are good for long term engine storage up to one year. After that, the engine should be started, warmed up, and retreated for an extended storage period.

**IMPORTANT:** Any time your engine will not be used for over six (6) months, the following recommendations for storing it and removing it from storage will help to minimize corrosion and deterioration. Use the AR41785 Engine Storage Kit. Follow recommended service procedure included with storage kit.

1. Change engine oil and replace filter. Used oil will not give adequate protection. (See CHANGING ENGINE OIL AND FILTER).
2. Service air cleaner. (See CLEAN OR REPLACE AIR FILTER).
3. Draining and flushing of cooling system is not necessary if engine is to be stored only for several months. However, for extended storage periods of a year or longer, it is recommended that the cooling system be drained, flushed, and refilled. Refill with appropriate coolant. (See DIESEL ENGINE COOLANT).
4. Drain fuel tank and add 30 ml (1 oz) of inhibitor to the fuel tank for each 15 L (4 U.S. gal) of tank capacity. Completely drain fuel filter and close fuel valve, if equipped.
5. Add 30 ml (1 oz) of inhibitor to the engine crankcase for each 0.95 L (1 qt) of crankcase oil.
6. Disconnect air intake piping from the manifold. Pour 90 ml (3 oz) of inhibitor into intake system and reconnect the piping.
7. Crank the engine several revolutions with starter (do not allow the engine to start).
8. Remove fan/alternator belt, if desired.
9. Remove and clean battery. Store them in a cool, dry place and keep them fully charged.
10. Clean the exterior of the engine with salt-free water and touchup any scratched or chipped painted surfaces with a good quality paint.
11. Coat all exposed (machined) metal surfaces with grease or corrosion inhibitor if not feasible to paint.
12. Seal all openings on engine with plastic bags and tape supplied in storage kit. Follow instructions supplied in kit.
13. Store the engine in a dry protected place. If engine must be stored outside, cover it with a waterproof canvas or other suitable protective material and use a strong waterproof tape.

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## Storage

### REMOVING ENGINE FROM LONG TERM STORAGE

Refer to the appropriate section for detailed services listed below or have your authorized servicing dealer or engine distributor perform services that you may not be familiar with.

**IMPORTANT: DO NOT operate starter more than 30 seconds at a time. Wait at least 2 minutes for starter to cool before trying again.**

1. Remove all protective coverings from engine. Unseal all openings in engine and remove covering from electrical systems.
2. Remove the battery from storage. Install battery (fully charged) and connect the terminals.
3. Install fan/alternator belt if removed.
4. Fill fuel tank.
5. Perform all appropriate prestarting checks. (See DAILY PRESTARTING CHECKS).
6. Crank engine for 20 seconds with starter (do not allow the engine to start). Wait 2 minutes and crank engine an additional 20 seconds to assure bearing surfaces are adequately lubricated.
7. Start engine and run at no load for several minutes. Warm up carefully and check all gauges before placing engine under load.
8. On the first day of operation after storage, check overall engine for leaks and check all gauges for correct operation.

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# Specifications

## GENERAL ENGINE SPECIFICATIONS

| ITEM                                       | UNIT OF MEASURE | 3029DF128 | 4039DF008 | 4039TF008 |
|--|-----------------|-----------|-----------|-----------|
| Number of Cylinders                        |                 | 3         | 4         | 4         |
| Fuel                                       |                 | Diesel    | Diesel    | Diesel    |
| Bore                                       | mm              | 106.5     | 106.5     | 106.5     |
| Stroke                                     | mm              | 110       | 110       | 110       |
| Displacement                               | L               | 2.9       | 3.9       | 3.9       |
| Compression Ratio                          |                 | 17.8:1    | 17.8:1    | 17.8:1    |
| POWER <sup>a</sup> @<br>1500 rpm (Prime)   | kW (hp)         | 26 (35)   | 35 (48)   | 55 (75)   |
| POWER <sup>a</sup> @<br>1500 rpm (Standby) | kW (hp)         | 30 (41)   | 38 (52)   | 61 (83)   |
| POWER <sup>a</sup> @<br>1800 rpm (Prime)   | kW (hp)         | 30 (41)   | 41 (56)   | 67 (91)   |
| POWER <sup>a</sup> @<br>1800 rpm (Standby) | kW (hp)         | 34 (46)   | 47 (64)   | 73 (99)   |
| Width (overall)                            | mm              | 582       | 588       | 588       |
| Length (overall)                           | mm              | 888       | 1016      | 1016      |
| Height (overall)                           | mm              | 931       | 960       | 979       |
| Weight (dry) <sup>b</sup>                  | kg              | 345       | 410       | 455       |
| Engine oil quantity                        | L               | 6         | 12        | 12        |
| Engine coolant<br>quantity                 | L               | 14.5      | 16.5      | 16.5      |

<sup>a</sup>With Fan

<sup>b</sup>Approximate

Continued on next page

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*Specifications*

| ITEM  | UNIT OF MEASURE | 4045HF158 | 4045TF158 | 4045TF258 | 4045DF158 |
|---|-----------------|-----------|-----------|-----------|-----------|
| Number of Cylinders   |                 | 4         | 4         | 4         | 4         |
| Fuel  |                 | Diesel    | Diesel    | Diesel    | Diesel    |
| Bore  | mm              | 106.5     | 106.5     | 106.5     | 106.5     |
| Stroke  | mm              | 127       | 127       | 127       | 127       |
| Displacement  | L               | 4.5       | 4.5       | 4.5       | 4.5       |
| Compression Ratio   |                 | 17.0:1    | 17.0:1    | 17.0:1    | 17.6:1    |
| POWER <sup>a</sup> @<br>1500 rpm (Prime)  | kW (hp)         | 88 (120)  | 61 (83)   | 72 (98)   | 41 (56)   |
| POWER <sup>a</sup> @<br>1500 rpm (Standby)  | kW (hp)         | 96 (131)  | 68 (92)   | 80 (109)  | 42 (57)   |
| POWER <sup>a</sup> @<br>300 rpm (Prime)   | kW (hp)         | 108 (147) | 72 (98)   | 80 (109)  | 48 (65)   |
| POWER <sup>a</sup> @<br>1800 rpm (Standby)  | kW (hp)         | 120 (163) | 79 (107)  | 88 (120)  | 51 (69)   |
| Width (overall)   | mm              | 798       | 668       | 668       | 668       |
| Length (overall)  | mm              | 1356      | 1219      | 1219      | 1219      |
| Height (overall)  | mm              | 1136      | 1010      | 1010      | 1010      |
| Weight (dry) <sup>b</sup>   | kg              | 446       | 436       | 436       | 391       |
| Engine oil quantity   | L               | 12        | 12        | 12        | 8         |
| Engine coolant<br>quantity  | L               | 25        | 25        | 25        | 20        |
| <sup>a</sup> With Fan<br><sup>b</sup> Approximate   |                 |           |           |           |           |
| Continued on next page <span style="float: right;">DPSG,CD03523,55 -19-10AUG99-2/3</span> |                 |           |           |           |           |












### Specifications

| ITEM                        | UNIT OF MEASURE | 6068HF158 | 6068TF158 | 6068TF258 |
|-----------------------------|-----------------|-----------|-----------|-----------|
| Number of Cylinders         |                 | 6         | 6         | 6         |
| Fuel                        |                 | Diesel    | Diesel    | Diesel    |
| Bore                        | mm              | 106.5     | 106.5     | 106.5     |
| Stroke                      | mm              | 127       | 127       | 127       |
| Displacement                | L               | 6.8       | 6.8       | 6.8       |
| Compression Ratio           |                 | 17.0:1    | 17.0:1    | 17.0:1    |
| POWER* @ 1500 rpm (Prime)   | kW (hp)         | 134 (182) | 92 (125)  | 105 (143) |
| POWER* @ 1500 rpm (Standby) | kW (hp)         | 148 (201) | 101 (137) | 116 (158) |
| POWER* @ 1800 rpm (Prime)   | kW (hp)         | 164 (223) | 108 (147) | 124 (169) |
| POWER* @ 1800 rpm (Standby) | kW (hp)         | 187 (254) | 119 (162) | 137 (186) |
| Width (overall)             | mm              | 798       | 668       | 668       |
| Length (overall)            | mm              | 1476      | 1383      | 1383      |
| Height (overall)            | mm              | 1136      | 1032      | 1032      |
| Weight (dry) <sup>b</sup>   | kg              | 613       | 593       | 593       |
| Engine oil quantity         | L               | 19.5      | 19.5      | 19.5      |
| Engine coolant quantity     | L               | 29        | 26        | 26        |
| *With Fan                   |                 |           |           |           |
| <sup>b</sup> Approximate    |                 |           |           |           |

DPSG.CD03523.55 -19-10AUG99-3/3

## Specifications

## UNIFIED INCH BOLT AND CAP SCREW TORQUE VALUES

|                             |  |  |   |  |  |  |
|-----------------------------|--|--|---|--|--|--|
| SAE Grade and Head Markings | 1 or 2 <sup>b</sup><br> | 5<br> | 5.1<br> | 5.2<br> | 8<br> | 8.2<br> |
| SAE Grade and Nut Markings  | 2<br>                   | 5<br> | 5<br>  | 5  | 8<br> | 8<br>   |

| Size  | Grade 1                 |       |                  |       | Grade 2 <sup>b</sup>    |       |                  |       | Grade 5, 5.1, or 5.2    |       |                  |       | Grade 8 or 8.2          |       |                  |       |
|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|
|       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       |
|       | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft |
| 1/4   | 3.7                     | 2.8   | 4.7              | 3.5   | 6                       | 4.5   | 7.5              | 5.5   | 9.5                     | 7     | 12               | 9     | 13.5                    | 10    | 17               | 12.5  |
| 5/16  | 7.7                     | 5.5   | 10               | 7     | 12                      | 9     | 15               | 11    | 20                      | 15    | 25               | 18    | 28                      | 21    | 35               | 26    |
| 3/8   | 14                      | 10    | 17               | 13    | 22                      | 16    | 27               | 20    | 35                      | 26    | 44               | 33    | 50                      | 36    | 63               | 46    |
| 7/16  | 22                      | 16    | 28               | 20    | 35                      | 26    | 44               | 32    | 55                      | 41    | 70               | 52    | 80                      | 58    | 100              | 75    |
| 1/2   | 33                      | 25    | 42               | 31    | 53                      | 39    | 67               | 50    | 85                      | 63    | 110              | 80    | 120                     | 90    | 150              | 115   |
| 9/16  | 48                      | 36    | 60               | 45    | 75                      | 56    | 95               | 70    | 125                     | 90    | 155              | 115   | 175                     | 130   | 225              | 160   |
| 5/8   | 67                      | 50    | 85               | 62    | 105                     | 78    | 135              | 100   | 170                     | 125   | 215              | 160   | 240                     | 175   | 300              | 225   |
| 3/4   | 120                     | 87    | 150              | 110   | 190                     | 140   | 240              | 175   | 300                     | 225   | 375              | 280   | 425                     | 310   | 550              | 400   |
| 7/8   | 190                     | 140   | 240              | 175   | 190                     | 140   | 240              | 175   | 490                     | 360   | 625              | 450   | 700                     | 500   | 875              | 650   |
| 1     | 290                     | 210   | 360              | 270   | 290                     | 210   | 360              | 270   | 725                     | 540   | 925              | 675   | 1050                    | 750   | 1300             | 975   |
| 1-1/8 | 400                     | 300   | 510              | 375   | 400                     | 300   | 510              | 375   | 900                     | 675   | 1150             | 850   | 1450                    | 1075  | 1850             | 1350  |
| 1-1/4 | 570                     | 425   | 725              | 530   | 570                     | 425   | 725              | 530   | 1300                    | 950   | 1650             | 1200  | 2050                    | 1500  | 2600             | 1950  |
| 1-3/8 | 750                     | 550   | 950              | 700   | 750                     | 550   | 950              | 700   | 1700                    | 1250  | 2150             | 1550  | 2700                    | 2000  | 3400             | 2550  |
| 1-1/2 | 1000                    | 725   | 1250             | 925   | 990                     | 725   | 1250             | 930   | 2250                    | 1650  | 2850             | 2100  | 3600                    | 2650  | 4550             | 3350  |

DO NOT use these values if a different torque value tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

<sup>a</sup> "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

<sup>b</sup> Grade 2 applies for hex cap screws (not hex bolts) up to 152 mm (6-in.) long. Grade 1 applies for hex cap screws over 152 mm (6-in.) long, and for all other types of bolts and screws of any length.

Fasteners should be replaced with the same or higher grade. If higher grade fasteners are used, these should only be tightened to the strength of the original.



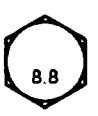











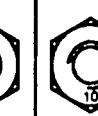





Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

DX,TORQ1 -19-20JUL94-1/1

## Specifications

## METRIC BOLT AND CAP SCREW TORQUE VALUES\*

|                                  |  |  |  |   |  |
|----------------------------------|--|--|--|---|--|
| Property Class and Head Markings | 4.8<br><br>4.8<br> | 8.8<br><br>8.8<br> | 9.8<br><br>9.8<br> | 10.9<br><br>10.9<br> | 12.9<br><br>12.9<br> |
| Property Class and Nut Markings  | 5<br><br>5<br>     | 10<br><br>10<br>   | 10<br><br>10<br>  | 10<br><br>10<br>    | 12<br><br>12<br>     |

| Size | Class 4.8               |       |                  |       | Class 8.8 or 9.8        |       |                  |       | Class 10.9              |       |                  |       | Class 12.9              |       |                  |       |
|------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|-------------------------|-------|------------------|-------|
|      | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       | Lubricated <sup>a</sup> |       | Dry <sup>a</sup> |       |
|      | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft | N-m                     | lb-ft | N-m              | lb-ft |
| M6   | 4.8                     | 3.5   | 6                | 4.5   | 9                       | 6.5   | 11               | 8.5   | 13                      | 9.5   | 17               | 12    | 15                      | 11.5  | 19               | 14.5  |
| M8   | 12                      | 8.5   | 15               | 11    | 22                      | 16    | 28               | 20    | 32                      | 24    | 40               | 30    | 37                      | 28    | 47               | 35    |
| M10  | 23                      | 17    | 29               | 21    | 43                      | 32    | 55               | 40    | 63                      | 47    | 80               | 60    | 75                      | 55    | 95               | 70    |
| M12  | 40                      | 29    | 50               | 37    | 75                      | 55    | 95               | 70    | 110                     | 80    | 140              | 105   | 130                     | 95    | 165              | 120   |
| M14  | 63                      | 47    | 80               | 60    | 120                     | 88    | 150              | 110   | 175                     | 130   | 225              | 165   | 205                     | 150   | 260              | 190   |
| M16  | 100                     | 73    | 125              | 92    | 190                     | 140   | 240              | 175   | 275                     | 200   | 350              | 255   | 320                     | 240   | 400              | 300   |
| M18  | 135                     | 100   | 175              | 125   | 260                     | 195   | 330              | 250   | 375                     | 275   | 475              | 350   | 440                     | 325   | 560              | 410   |
| M20  | 190                     | 140   | 240              | 180   | 375                     | 275   | 475              | 350   | 530                     | 400   | 675              | 500   | 625                     | 460   | 800              | 580   |
| M22  | 260                     | 190   | 330              | 250   | 510                     | 375   | 650              | 475   | 725                     | 540   | 925              | 675   | 850                     | 625   | 1075             | 800   |
| M24  | 330                     | 250   | 425              | 310   | 650                     | 475   | 825              | 600   | 925                     | 675   | 1150             | 850   | 1075                    | 800   | 1350             | 1000  |
| M27  | 490                     | 360   | 625              | 450   | 950                     | 700   | 1200             | 875   | 1350                    | 1000  | 1700             | 1250  | 1600                    | 1150  | 2000             | 1500  |
| M30  | 675                     | 490   | 850              | 625   | 1300                    | 950   | 1650             | 1200  | 1850                    | 1350  | 2300             | 1700  | 2150                    | 1600  | 2700             | 2000  |
| M33  | 900                     | 675   | 1150             | 850   | 1750                    | 1300  | 2200             | 1650  | 2500                    | 1850  | 3150             | 2350  | 2900                    | 2150  | 3700             | 2750  |
| M36  | 1150                    | 850   | 1450             | 1075  | 2250                    | 1650  | 2850             | 2100  | 3200                    | 2350  | 4050             | 3000  | 3750                    | 2750  | 4750             | 3500  |

DO NOT use these values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only. Check tightness of fasteners periodically.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical property class.

Fasteners should be replaced with the same or higher property class. If higher property class fasteners are used, these should only be tightened to the strength of the original.

\* "Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated without any lubrication.

Make sure fasteners threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

Tighten plastic insert or crimped steel-type lock nuts to approximately 50 percent of the dry torque shown in the chart, applied to the nut, not to the bolt head. Tighten toothed or serrated-type lock nuts to the full torque value.

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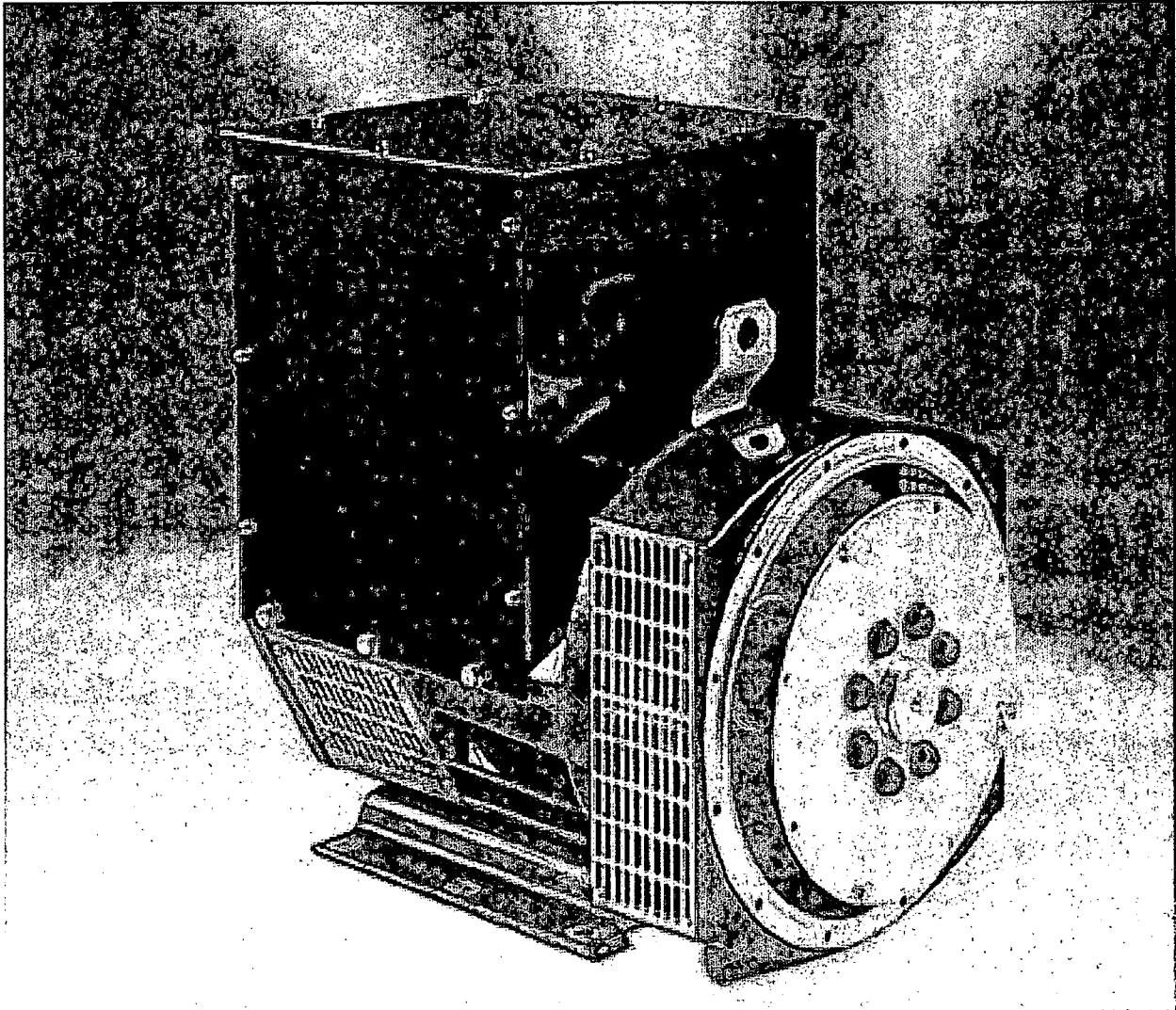
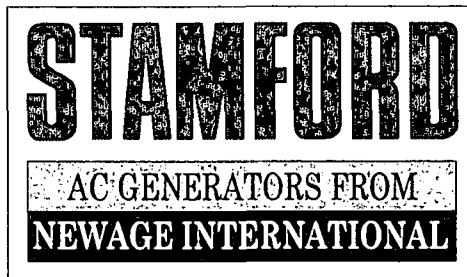
# **SPARE PARTS**

The spare parts catalogue is too extensive for hard copy presentation.

Please refer to copy on enclosed CD.







## **Installation, Service & Maintenance Manual**

**for AC generators with the following prefixes:**

**UCI; UCM; UCD 224 & 274 .**

# SAFETY PRECAUTIONS

Before operating the generating set, read the generating set operation manual and this generator manual and become familiar with it and the equipment.

## SAFE AND EFFICIENT OPERATION CAN ONLY BE ACHIEVED IF THE EQUIPMENT IS CORRECTLY OPERATED AND MAINTAINED.

Many accidents occur because of failure to follow fundamental rules and precautions.

## ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

- Ensure installation meets all applicable safety and local electrical codes. Have all installations performed by a qualified electrician.
- Do not operate the generator with protective covers, access covers or terminal box covers removed.
- Disable engine starting circuits before carrying out maintenance.
- Disable closing circuits and/or place warning notices on any circuit breakers normally used for connection to the mains or other generators, to avoid accidental closure.

Observe all **IMPORTANT, CAUTION, WARNING, and DANGER** notices, defined as:

**Important !** Important refers to hazard or unsafe method or practice which can result in product damage or related equipment damage.

**Caution !** Caution refers to hazard or unsafe method or practice which can result in product damage or personal injury.



**Warning !**

Warning refers to a hazard or unsafe method or practice which **CAN** result in severe personal injury or possible death.



**Danger !**

Danger refers to immediate hazards which **WILL** result in severe personal injury or death.

Due to our policy of continuous improvement, details in this manual which were correct at time of printing, may now be due for amendment. Information included must therefore not be regarded as binding.

## FOREWORD

The function of this book is to provide the user of the Stamford generator with an understanding of the principles of operation, the criteria for which the generator has been designed, and the installation and maintenance procedures. Specific areas where the lack of care or use of incorrect procedures could lead to equipment damage and/or personal injury are highlighted, with **WARNING** and/or **CAUTION** notes, and it is **IMPORTANT** that the contents of this book are read and understood before proceeding to fit or use the generator.

The Service, Sales and technical staff of Newage International are always ready to assist and reference to the company for advice is welcomed.




**Warning !**

**Incorrect installation, operation, servicing or replacement of parts can result in severe personal injury or death, and/or equipment damage.**  
**Service personnel must be qualified to perform electrical and mechanical service.**

## EC DECLARATION OF INCORPORATION

All Stamford generators are supplied with a declaration of incorporation for the relevant EC legislation, typically in the form of a label as below.

|  |                           |
|--|---------------------------|
| <br><b>EC DECLARATION OF INCORPORATION</b>  |                           |
| <small>IN ACCORDANCE WITH THE SUPPLY OF MACHINERY (SAFETY) REGULATIONS 1992 AND THE SUPPLY OF MACHINERY (SAFETY) (AMENDMENT) REGULATIONS 1994 IMPLEMENTING THE EC MACHINERY DIRECTIVE 89/392/EEC AS AMENDED BY 91/368/EEC.</small>                         |                           |
| <small>THIS STAMFORD A.C. GENERATOR WAS MANUFACTURED BY OR ON BEHALF OF<br/> <b>NEWAGE INTERNATIONAL LTD</b><br/>         BARNACK ROAD STAMFORD LINCOLNSHIRE ENGLAND.</small>  |                           |
| <small>THIS COMPONENT MACHINERY MUST NOT BE PUT INTO SERVICE UNTIL THE MACHINERY INTO WHICH IT IS TO BE INCORPORATED HAS BEEN DECLARED IN CONFORMITY WITH THE PROVISIONS OF THE SUPPLY OF MACHINERY (SAFETY) REGULATIONS 1995/MACHINERY DIRECTIVE.</small> |                           |
| <small>FOR AND ON BEHALF OF NEWAGE INTERNATIONAL LIMITED</small>   |                           |
| <b>NAME:</b>   | <b>LAWRENCE HAYDOCK</b>   |
| <b>POSITION:</b>   | <b>TECHNICAL DIRECTOR</b> |
| <b>SIGNATURE:</b>  |                           |
| <small>THIS COMPONENT MACHINERY CARRIES THE CE MARK FOR COMPLIANCE WITH THE STATUTORY REQUIREMENTS FOR THE IMPLEMENTATION OF THE FOLLOWING DIRECTIVES</small>  |                           |
| <small>The EMC Directive 89/336/EEC</small>  |                           |
| <small><b>WARNING!</b> This Component Machinery shall not be used in the Residential, Commercial and Light Industrial environment unless it also conforms to the relevant standard (EN 50081 - 1) REFER TO FACTORY FOR DETAILS</small>                     |                           |
| <small>ii) The Low Voltage Directive 73/23/EEC as amended by 93/68/EEC</small>   |                           |

Under the EC Machinery Directive section 1.7.4. It is the responsibility of the generator set builder to ensure the generator identity is clearly displayed on the front cover of this book.



## ELECTROMAGNETIC COMPATIBILITY

### Additional Information

#### European Union

#### Council Directive 89/336/EEC

For installations within the European Union, electrical products must meet the requirements of the above directive, and Newage ac generators are supplied on the basis that:

- They are to be used for power-generation or related function.
- They are to be applied in one of the following environments:

Portable (open construction - temporary site supply)  
 Portable (enclosed - temporary site supply)  
 Containerised (temporary or permanent site supply)  
 Ship-borne below decks (marine auxiliary power)  
 Commercial vehicle (road transport / refrigeration etc)  
 Rail transport (auxiliary power)  
 Industrial vehicle (earthmoving, cranes etc)

Fixed installation (industrial - factory / process plant)

Fixed installation (residential, commercial and light industrial - home / office / health)

Energy management (Combined heat and power and/or peak lopping)

Alternative energy schemes

- The standard generators are designed to meet the 'industrial' emissions and immunity standards. Where the generator is required to meet the residential, commercial and light industrial emissions and immunity standards reference should be made to Newage document reference N4/X/011, as additional equipment may be required.
- The installation earthing scheme involves connection of the generator frame to the site protective earth conductor using a minimum practical lead length.
- Maintenance and servicing with anything other than factory supplied or authorised parts will invalidate any Newage liability for EMC compliance.
- Installation, maintenance and servicing is carried out by adequately trained personnel fully aware of the requirements of the relevant EC directives.

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# SECTION 1

## INTRODUCTION

### 1.1 INTRODUCTION

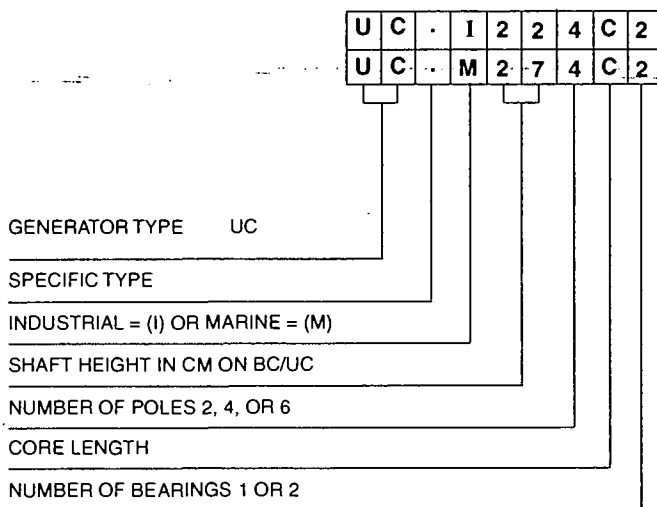
The UC22/27 range of generators is of brushless rotating field design, available up to 660V/50Hz (1500 rpm) or 60Hz (1800 rpm), and built to meet BS5000 Part 3 and international standards.

All the UC22/27 range are self-excited with excitation power derived from the main output windings, using either the SX460/SX440/SX421 AVR. The UC22 is also available with specific windings and a transformer controlled excitation system.

A permanent magnet generator (PMG) powered excitation system is available as an option using either the MX341 or MX321 AVR.

Detailed specification sheets are available on request.

### 1.2 DESIGNATION



### 1.3 SERIAL NUMBER LOCATION AND IDENTITY NUMBER LOCATION

Each generator is metal stamped with it's own unique serial number, the location of this number is described below.

UCI and UCM generators have their serial number stamped into the upper section of the drive end frame to end bracket adaptor ring, shown as item 31 in the parts lists at the back of this book.

UCD generators have their serial number stamped into the top of the drive end adaptor /fan shroud casting. If for any reason this casting is removed, it is imperative that care is taken to refit it to the correct generator to ensure correct identification is retained.

Inside the terminal box two adhesive rectangular labels have been fixed, each carrying the generators unique identity number. One label has been fixed to the inside of the terminal box sheet metal work, and the second label fixed to the main frame of the generator.

### 1.4 RATING PLATE

The generator has been supplied with a self adhesive rating plate label to enable fitting after final assembly and painting.

It is intended that this label will be stuck to the outside of the terminal box on the left hand side when viewed from the N.D.E. To assist with squarely positioning the label, location protrusions have been made in the sheet metalwork.

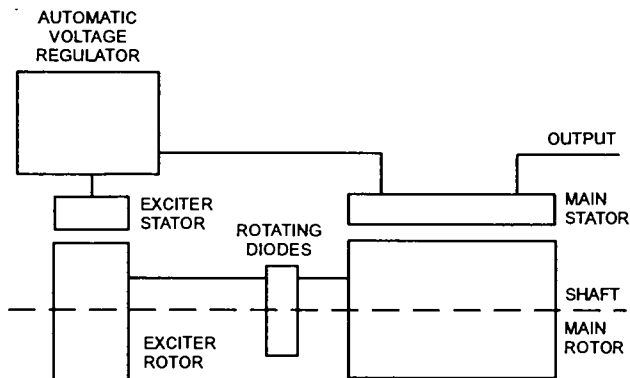
A CE Mark label is also supplied loose for fitment after final assembly and painting. This should be attached to an external surface of the Generator at a suitable location where it will not be obscured by the customer's wiring or other fittings.

The surface in the area where a label is to be stuck must be flat, clean, and any paint finish be fully dry before attempting to attach label. Recommended method for attaching label is peel and fold back sufficient of the backing paper to expose some 20 mm of label adhesive along the edge which is to be located against the sheet metal protrusions. Once this first section of label has been carefully located and stuck into position the backing paper can be progressively removed, as the label is pressed down into position. The adhesive will achieve a permanent bond in 24 hours.

## SECTION 2

### PRINCIPLE OF OPERATION

#### 2.1 SELF-EXCITED AVR CONTROLLED GENERATORS

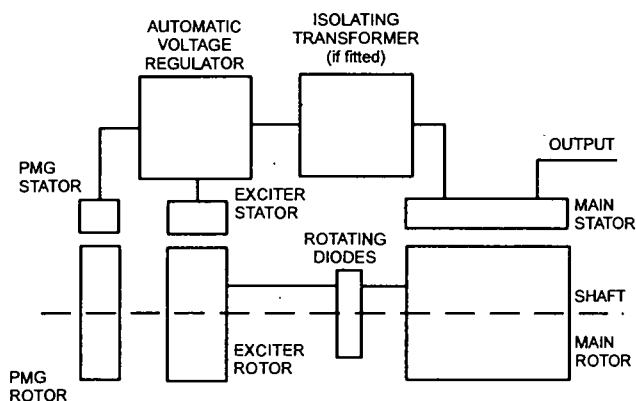


The main stator provides power for excitation of the exciter field via the SX460 (SX440 or SX421) AVR which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage-sensing signal derived from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature.

The SX460 or SX440 AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine.

The SX421 AVR in addition to the SX440 features has three phase rms sensing and also provides for over voltage protection when used in conjunction with an external circuit breaker (switchboard mounted).

#### 2.2 PERMANENT MAGNET GENERATOR (PMG) EXCITED - AVR CONTROLLED GENERATORS



The permanent magnet generator (PMG) provides power for excitation of the exciter field via the AVR (MX341 or MX321) which is the controlling device governing the level of excitation provided to the exciter field. The AVR responds to a voltage sensing signal derived, via an isolating transformer in the case of MX321 AVR, from the main stator winding. By controlling the low power of the exciter field, control of the high power requirement of the main field is achieved through the rectified output of the exciter armature.

The PMG system provides a constant source of excitation power irrespective of main stator loading and provides high motor starting capability as well as immunity to waveform distortion on the main stator output created by non linear loads, e.g. thyristor controlled dc motor.

The MX341 AVR senses average voltage on two phases ensuring close regulation. In addition it detects engine speed and provides an adjustable voltage fall off with speed, below a pre-selected speed (Hz) setting, preventing over-excitation at low engine speeds and softening the effect of load switching to relieve the burden on the engine. It also provides over-excitation protection which acts following a time delay, to de-excite the generator in the event of excessive exciter field voltage.

The MX321 provides the protection and engine relief features of the MX341 and additionally incorporates 3 phase rms sensing and over-voltage protection.

The detailed function of all the AVR circuits is covered in the load testing (subsection 4.7).

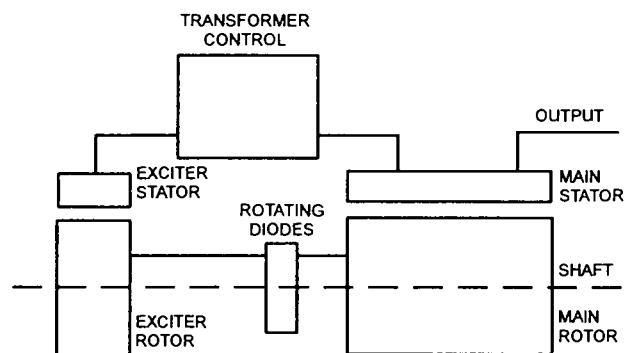
#### 2.3 AVR ACCESSORIES

The SX440, SX421, MX341 and MX321 AVRs incorporate circuits which, when used in conjunction with accessories, can provide for parallel operation either with 'droop' or 'astatic' control, VAR/ PF control and in the case of the MX321 AVR, short circuit current limiting.

Function and adjustment of the accessories which can be fitted inside the generator terminal box are covered in the accessories section of this book.

Separate instructions are provided with other accessories available for control panel mounting.

#### 2.4 TRANSFORMER CONTROLLED GENERATORS



The main stator provides power for excitation of the exciter field via a transformer rectifier unit. The transformer combines voltage and current elements derived from the main stator output to form the basis of an open-loop control system, which is self regulating in nature. The system inherently compensates for load current magnitude and power factor and provides short circuit maintenance in addition to a good motor starting performance.

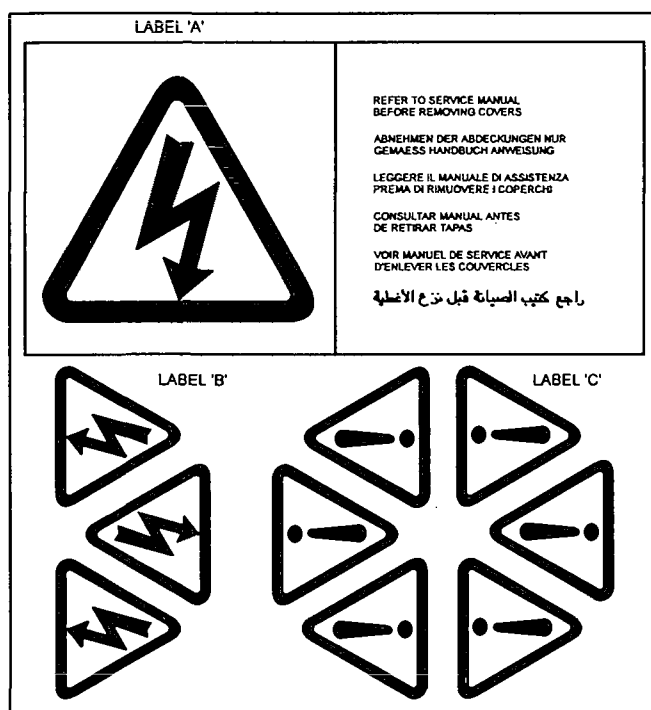
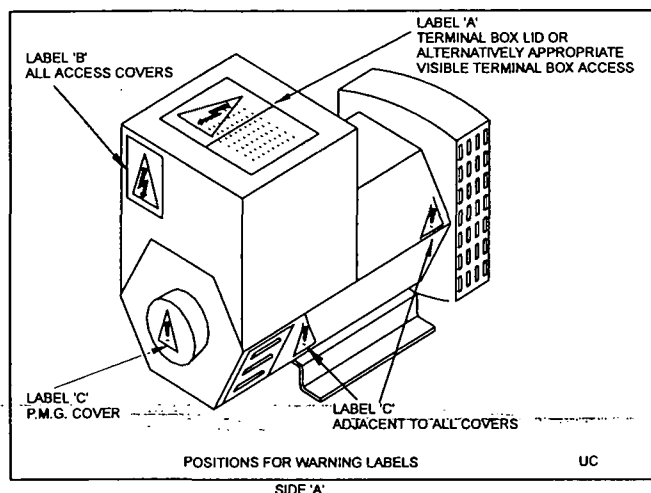
Three phase generators normally have a three phase transformer control for improved performance with unbalanced loads but a single phase transformer option is available.

No accessories can be provided with this control system.

## SECTION 3

### APPLICATION OF THE GENERATOR

The generator is supplied as a component part for installation in a generating set. It is not, therefore, practicable to fit all the necessary warning/hazard labels during generator manufacture. The additional labels required are packaged with this Manual, together with a drawing identifying their locations. (See below).



It is the responsibility of the generating set manufacturer to ensure that the correct labels are fitted, and are clearly visible.

The generators have been designed for use in a maximum ambient temperature of 40°C and altitude less than 1000m above sea level in accordance with BS5000.

Ambients in excess of 40°C and altitudes above 1000m can be tolerated with reduced ratings - refer to the generator nameplate for rating and ambient. In the event that the generator is required to operate in an ambient in excess of the nameplate value or at altitudes in excess of 1000 metres above sea level, refer to the factory.

The generators are of air-ventilated screen protected drip-proof design and are not suitable for mounting outdoors unless adequately protected by the use of canopies. Anti-condensation heaters are recommended during storage and for standby duty to ensure winding insulation is maintained in good condition.

When installed in a closed canopy it must be ensured that the ambient temperature of the cooling air to the generator does not exceed that for which the generator has been rated.

The canopy should be designed such that the engine air intake to the canopy is separated from the generator intake, particularly where the radiator cooling fan is required to draw air into the canopy. In addition the generator air intake to the canopy should be designed such that the ingress of moisture is prohibited, preferably by use of a 2 stage filter.

The air intake/outlet must be suitable for the air flow given in the following table with additional pressure drops less than or equal to those given below:

| Frame | Air Flow    |             | Additional (intake/outlet) Pressure Drop |
|-------|-------------|-------------|--|
|       | 50Hz        | 60Hz        |  |
| UC22  | 0.216m³/sec | 0.281m³/sec | 6mm water gauge                          |
|       | 458cfm      | 595cfm      | 0.25"                                    |
| UCD22 | 0.25m³/sec  | 0.31m³/sec  | 6mm water gauge                          |
|       | 530cfm      | 657cfm      | 0.25"                                    |
| UC27  | 0.514m³/sec | 0.617m³/sec | 6mm water gauge                          |
|       | 1090cfm     | 1308cfm     | 0.25"                                    |
| UCD27 | 0.58m³/sec  | 0.69m³/sec  | 6mm water gauge                          |
|       | 1230cfm     | 1463cfm     | 0.25"                                    |

**Important !** Reduction in cooling air flow or inadequate protection to the generator can result in damage and/or failure of windings.

Dynamic balancing of the generator rotor assembly has been carried out during manufacture in accordance with BS 6861 Part 1 Grade 2.5 to ensure vibration limits of the generator are in accordance with BS 4999 Part 142.

The main vibration frequencies produced by the generator are as follows:-

|        |          |       |
|--------|----------|-------|
| 4 pole | 1500 rpm | 25 Hz |
| 4 pole | 1800 rpm | 30 Hz |

However, vibrations induced by the engine are complex and contain frequencies of 1.5, 3, 5 or more times the fundamental frequency of vibration. These induced vibrations can result in generator vibration levels higher than those derived from the generator itself. It is the responsibility of the generating set designer to ensure that the alignment and stiffness of the bedplate and mountings are such that the vibration limits of BS5000 Part 3 are not exceeded.

In standby applications where the running time is limited and reduced life expectancy is accepted, higher levels than specified in BS5000 can be tolerated, up to a maximum of 18mm/sec.

Two bearing generators open coupled require a substantial bedplate with engine/generator mounting pads to ensure a good base for accurate alignment. Close coupling of engine to generator can increase the overall rigidity of the set. For the purposes of establishing set design the bending moment at the engine flywheel housing to generator adaptor interface should not exceed 1000ft.lb. (140 kgm). A flexible coupling, designed to suit the specific engine/generator combination, is recommended to minimise torsional effects.

Belt driven applications of two bearing generators require the pulley diameter and design to be such that the side load or force applied to the shaft is central to the extension and does not exceed the values given in the table below:-

| Frame | Side Load |      | Shaft extension mm |
|-------|-----------|------|--------------------|
|       | kgf       | N    |                    |
| UC22  | 408       | 4000 | 110                |
| UC27  | 510       | 5000 | 140                |

In instances where shaft extensions greater than specified in the table have been supplied reference must be made to the factory for appropriate loadings.

Alignment of single bearing generators is critical and vibration can occur due to the flexing of the flanges between the engine and generator. As far as the generator is concerned the maximum bending moment at this point must not exceed 1000ft.lb. (140 kgm). A substantial bedplate with engine/generator mounting pads is required.

It is expected that the generator will be incorporated into a generating set operating in an environment, where the maximum shock load experienced by the generator will not exceed 3g. in any plane. If shock loads in excess of 3g are to be encountered, anti-vibration mountings must be incorporated into the generating set to ensure they absorb the excess.

The maximum bending moment of the engine flange must be checked with the engine manufacturer.

Generators can be supplied without a foot, providing the option for customers own arrangement. See SECTION 4.2.1 for assembly procedure.

Torsional vibrations occur in all engine-driven shaft systems and may be of a magnitude to cause damage at certain critical speeds. It is therefore necessary to consider the torsional vibration effect on the generator shaft and couplings.

It is the responsibility of the generator set manufacturer to ensure compatibility, and for this purpose drawings showing the shaft dimensions and rotor inertias are available for customers to forward to the engine supplier. In the case of single bearing generators coupling details are included.

**Important !** Torsional incompatibility and/or excessive vibration levels can cause damage or failure of generator and/or engine components.

The terminal box is constructed with removable panels for easy adaptation to suit specific glanding requirements. Within the terminal box there are insulated terminals for line and neutral connections and provision for earthing. Additional earthing points are provided on the generator feet.

The neutral is NOT connected to the frame.

The main stator winding has leads brought out to the terminals in the terminal box.



**Warning !**

No earth connections are made on the generator and reference to site regulations for earthing must be made. Incorrect earthing or protection arrangements can result in personal injury or death.

Fault current curves (decrement curves), together with generator reactance data, are available on request to assist the system designer to select circuit breakers, calculate fault currents and ensure discrimination within the load network.




**Warning !**

Incorrect installation, service or replacement of parts can result in severe personal injury or death, and/or equipment damage. Service personnel must be qualified to perform electrical and mechanical service.

## SECTION 4

### INSTALLATION - PART 1

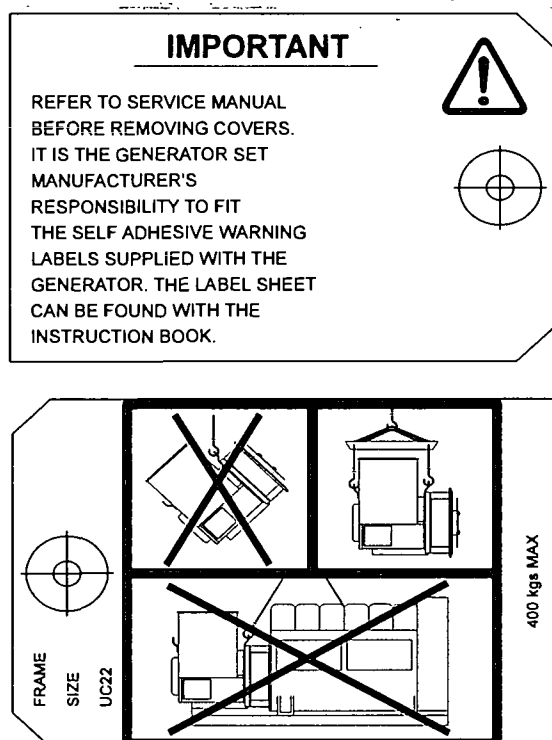
#### 4.1 LIFTING



**Warning !**

Incorrect lifting or inadequate lifting capacity can result in severe personal injury or equipment damage. **MINIMUM LIFTING CAPACITY REQUIRED IS 750Kg.** Generator lifting lugs should **NOT** be used for lifting the complete generator set.

Two lifting lugs are provided for use with a shackle and pin type lifting aid. Chains of suitable length and lifting capacity must be used. Lifting points are designed to be as close to the centre of gravity of the generator as possible, but due to design restrictions it is not possible to guarantee that the generator frame will remain horizontal while lifting. Care is therefore needed to avoid personal injury or equipment damage. The correct lifting arrangement is shown on the label attached to the lifting lug. (See sample below).



Single bearing generators are supplied fitted with a rotor retaining bar at the non-drive end of the shaft.

To remove retaining bar:

1. Remove the four screws holding the sheet metal cover at the non drive end and remove cover
2. Remove central bolt holding the retaining bar to the shaft
3. Refit sheet metal cover.

Once the bar is removed, to couple the rotor to engine, the rotor is free to move in the frame, and care is needed during coupling and alignment to ensure the frame is kept in the horizontal plane.

Generators fitted with a PMG excitation system are not fitted with retaining bar. Refer to frame designation to verify generator type (subsection 1.2)

#### 4.2 ASSEMBLY

During the assembly of the generator to the engine it will be necessary firstly to carefully align, then rotate, the combined generator rotor - engine crankshaft assembly, as part of the construction process, to allow location, insertion and tightening of the coupling bolts. This requirement to rotate the combined assemblies exists for both single and two bearing units.

During the assembly of single bearing units it is necessary to align the generator's coupling holes with the engine flywheel holes; it is suggested that two diametrically opposite location dowel pins are fitted to the engine flywheel, over which the generator coupling can slide into final location into the engine flywheel spigot recess. The dowels must be removed and replaced by coupling bolts before the final bolt tightening sequence.

While fitting and tightening the coupling bolts it will be necessary to rotate the engine crankshaft - generator rotor assembly. Care should be taken to ensure that rotation is carried out in an approved manner that ensures safe working practice when reaching inside the machine to insert or tighten coupling bolts, and that no component of the assembly is damaged by non-approved methods of assembly rotation.

Engine manufacturers have available a proprietary tool or facility designed to enable manual rotation of the crankshaft assembly. This must always be used, having been engineered as an approved method of assembly rotation, engaging the manually driven pinion with the engine flywheel starter ring-gear.

**Caution !** Before working inside the generator, during the aligning and fitting of coupling bolts, care should be taken to lock the assembly to ensure there is no possibility of rotational movement.

##### 4.2.1 NO FOOT OPTION

Generators can be supplied without a foot providing the option for customers own arrangement.

For details of mounting this arrangement, see the general arrangement drawing supplied with the generator. Alternatively refer to Newage International for a copy of the latest general arrangement drawing showing the 'NO FOOT OPTION' appropriate to your generator.

## 4.2.2 TWO BEARING GENERATORS

A flexible coupling should be fitted and aligned in accordance with the coupling manufacturer's instruction.

If a close coupling adaptor is used the alignment of machined faces must be checked by offering the generator up to the engine. Shim the generator feet if necessary. Ensure adaptor guards are fitted after generator/engine assembly is complete. Open coupled sets require a suitable guard, to be provided by the set builder.

In the case of belt driven generators, ensure alignment of drive and driven pulleys to avoid axial load on the bearings. Screw type tensioning devices are recommended to allow accurate adjustment of belt tension whilst maintaining pulley alignment. Side loads should not exceed values given in SECTION 3.

Belt and pulley guards must be provided by the set builder.

**Important !** Incorrect belt tensioning will result in excessive bearing wear.

**Caution !** Incorrect guarding and/or generator alignment can result in personal injury and/or equipment damage.

## 4.2.3 SINGLE BEARING GENERATORS

Alignment of single bearing generators is critical. If necessary shim the generator feet to ensure alignment of the machined surfaces.

For transit and storage purposes the generator frame spigot and rotor coupling plates have been coated with a rust preventative. This MUST BE removed before assembly to engine.

A practical method for removal of this coating is to clean the mating surface areas with a de-greasing agent based on a petroleum solvent.

**Care should be taken not to allow any cleaning agent to come into prolonged contact with skin.**

The sequence of assembly to the engine should generally be as follows:

1. On the engine check the distance from the coupling mating face on the flywheel to the flywheel housing mating face. This should be within  $\pm 0.5$ mm of nominal dimension. This is necessary to ensure that a thrust is not applied to the a.c. generator bearing or engine bearing.
2. Check that the bolts securing the flexible plates to the coupling hub are tight and locked into position. Torque tightening is 24.9kgfm (244Nm; 180 lb ft).
- 2a. **UCD224 Only**  
Torque tightening is 15.29 kgfm (150Nm; 110 lb ft).

3. Remove covers from the drive end of the generator to gain access to coupling and adaptor bolts.
4. Check that coupling discs are concentric with adaptor spigot. This can be adjusted by the use of tapered wooden wedges between the fan and adaptor. Alternatively the rotor can be suspended by means of a rope sling through the adaptor opening.
5. Offer the a.c. generator to engine and engage both coupling discs and housing spigots at the same time, finally pulling home by using the housing and coupling bolts. Use heavy gauge washers between bolt head and discs on disc to flywheel bolts.
6. Tighten coupling disc to flywheel. Refer to engine manual for torque setting of disc to flywheel bolts.
7. Remove wooden wedges.

**Caution !** Incorrect guarding and/or generator alignment can result in personal injury and/or equipment damage.

## 4.3 EARTHING

The generator frame should be solidly bonded to the generating set bedplate. If antivibration mounts are fitted between the generator frame and its bedplate a suitably rated earth conductor (normally one half of the cross sectional area of the main line cables) should bridge across the antivibration mount.



**Warning !**

**Refer to local regulations to ensure that the correct earthing procedure has been followed.**

## 4.4 PRE-RUNNING CHECKS

### 4.4.1 INSULATION CHECK

Before starting the generating set, both after completing assembly and after installation of the set, test the insulation resistance of windings.

The AVR should be disconnected during this test.

A 500V Megger or similar instrument should be used. Disconnect any earthing conductor connected between neutral and earth and megger an output lead terminal U, V or W to earth. The insulation resistance reading should be in excess of 5MΩ to earth. Should the insulation resistance be less than 5MΩ the winding must be dried out as detailed in the Service and Maintenance section of this Manual.

**Important !** The windings have been H.V. tested during manufacture and further H.V. testing may degrade the insulation with consequent reduction in operating life. Should it be necessary to demonstrate H.V. testing, for customer acceptance, the tests must be carried out at reduced voltage levels i.e. Test Voltage = 0.8 (2 X Rated Voltage + 1000)

#### 4.4.2 DIRECTION OF ROTATION

The generator is supplied to give a phase sequence of U V W with the generator running clockwise looking at the drive end (unless otherwise specified at the time of ordering). If the generator phase rotation has to be reversed after the generator has been despatched apply to factory for appropriate wiring diagrams.

#### UCI224, UCI274, UCM224, UCM274

Machines are fitted with bi-directional fans and are suitable for running in either direction of rotation.

#### UCD224, UCD274

Machines are fitted with uni-directional fans and are suitable for running in one direction only.

#### 4.4.3 VOLTAGE AND FREQUENCY

Check that the voltage and frequency levels required for the generating set application are as indicated on the generator nameplate.

Three phase generators normally have a 12 ends out reconnectable winding. If it is necessary to reconnect the stator for the voltage required, refer to diagrams in the back of this manual.

#### 4.4.4 AVR SETTINGS

To make AVR selections and adjustments remove the AVR cover and refer to 4.4.4.1, 4.4.4.2, 4.4.4.3, 4.4.4.4 or 4.4.4.5 depending upon type of AVR fitted. Reference to the generator nameplate will indicate AVR type (SX460, SX440, SX421, MX341 or MX321).

Most of the AVR adjustments are factory set in positions which will give satisfactory performance during initial running tests. Subsequent adjustment may be required to achieve optimum performance of the set under operating conditions. Refer to 'Load Testing' section for details.

##### 4.4.4.1 TYPE SX460 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 1 for location of selection links.

##### 1. Frequency selection

50Hz operation LINK C-50

60Hz operation LINK C-60

##### 2. External hand trimmer selection

No external hand trimmer LINK 1-2

External hand trimmer required - REMOVE LINK 1-2 and connect trimmer across terminals 1 and 2.

##### 3. AVR Input Selection

High voltage (220/240V) Input NO LINK

Low voltage (110/120V) Input LINK 3-4

Refer to diagram in the back of this manual to determine wiring.

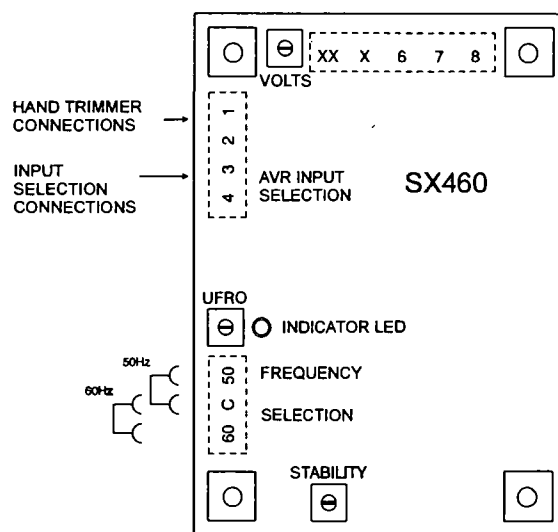


Fig. 1

##### 4.4.4.2 TYPE SX440 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 2 for location of selection links.

##### 1. Frequency selection terminals

50Hz operation LINK C-50

60Hz operation LINK C-60

##### 2. Stability selection terminals

Frame UC22 LINK A-C

Frame UC27 LINK B-C

##### 3. Sensing selection terminals

LINK 2-3

LINK 4-5

LINK 6-7

##### 4. Excitation Interruption Link

LINK K1-K2

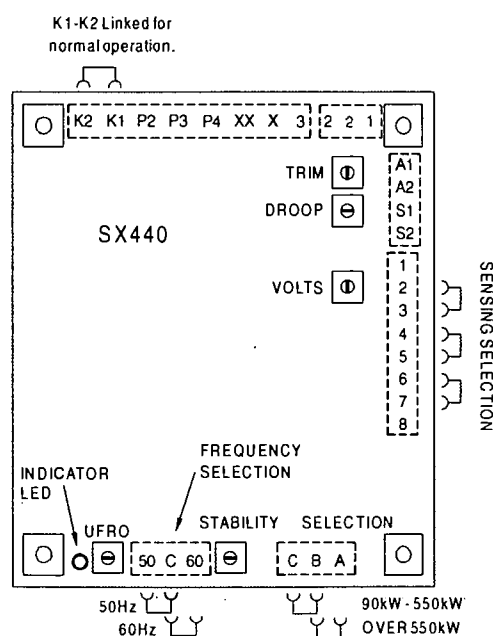


Fig. 2

#### 4.4.4.3 TYPE SX421 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 3 for location of selection links.

##### 1. Frequency selection terminals

50Hz operation LINK C-50

60Hz operation LINK C-60

##### 2. Stability selection terminals

Depending upon kW output LINK B-D

or LINK A-C

or LINK B-C

##### 3. Terminals K1 - K2

Excitation circuit breaker closed

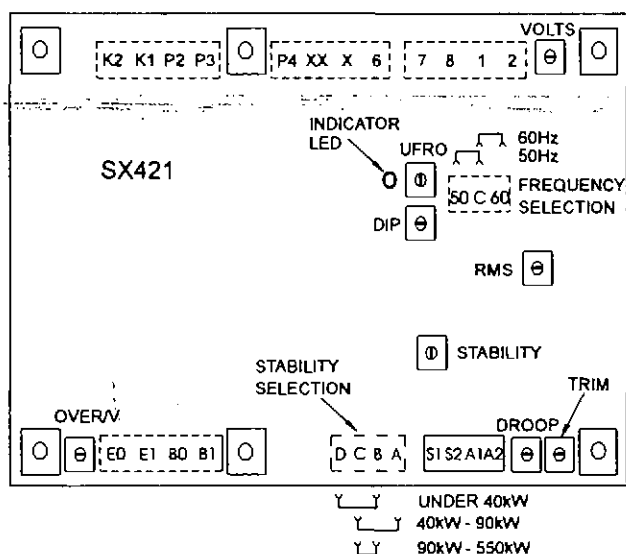


Fig. 3

#### 4.4.4.4 TYPE MX341 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 4 for location of setting links.

##### 1. Frequency selection terminals

50Hz operation LINK 2-3

60Hz operation LINK 1-3

##### 2. Stability selection terminals

Frame UC22 LINK A-C

Frame UC27 LINK B-C

##### 3. Sensing selection terminals \*

LINK 2-3

LINK 4-5

LINK 6-7

##### 4. Excitation Interruption Link

LINK K1-K2

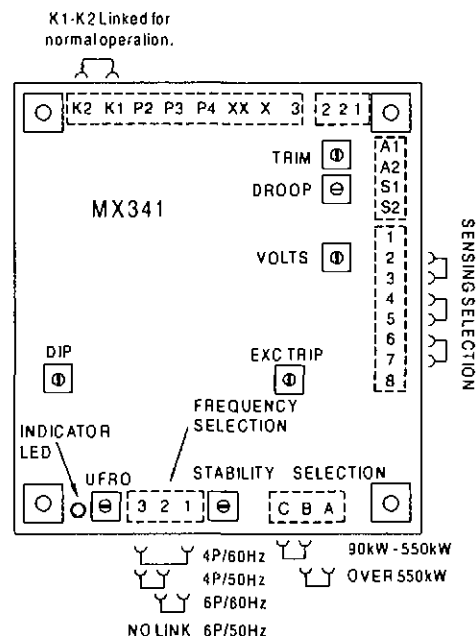


Fig. 4

#### 4.4.4.5 TYPE MX321 AVR

The following 'jumper' connections on the AVR should be checked to ensure they are correctly set for the generating set application.

Refer to Fig. 5 for location of setting links.

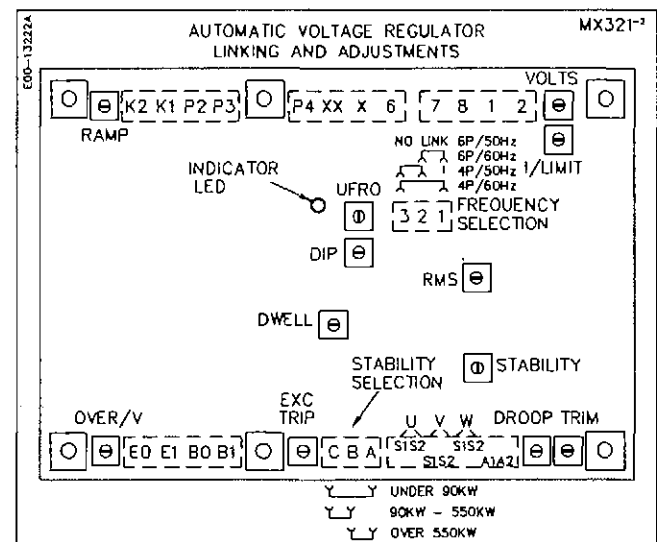


Fig. 5

##### 1. Frequency selection terminals

50Hz operation LINK 2-3

60Hz operation LINK 1-3

##### 2. Stability selection terminals

Frame UC22 LINK A-C

Frame UC27 LINK B-C

##### 3. Terminals K1 - K2

Excitation circuit breaker closed.

If this option not fitted, K1 - K2 linked at auxiliary terminal block.

#### 4.4.5 TRANSFORMER CONTROLLED EXCITATION SYSTEM (Series 5)

This control system is identified with the digit 5 as the last digit of the frame size quoted on the nameplate.

The excitation control is factory set for the specific voltage shown on the nameplate and requires no adjustment.

#### 4.5 GENERATOR SET TESTING



**Warning !**

During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments.

##### 4.5.1 TEST METERING/CABLING

Connect any instrument wiring and cabling required for initial test purposes with permanent or spring-clip type connectors.

Minimum instrumentation for testing should be line - line or line to neutral voltmeter, Hz meter, load current metering and kW meter. If reactive load is used a power factor meter is desirable.

**Important !** When fitting power cables for load testing purposes, ensure cable voltage rating is at least equal to the generator rated voltage. The load cable termination should be placed on top of the winding lead termination and clamped with the nut provided.

**Caution !** Check that all wiring terminations for internal or external wiring are secure, and fit all terminal box covers and guards. Failure to secure wiring and/or covers may result in personal injury and/or equipment failure.

#### 4.6 INITIAL START-UP



**Warning !**

During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments. Refit all access covers after adjustments are completed.

On completion of generating set assembly and before starting the generating set ensure that all engine manufacturer's pre-running procedures have been completed, and that adjustment of the engine governor is such that the generator will not be subjected to speeds in excess of 125% of the rated speed.

**Important !** Overspeeding of the generator during initial setting of the speed governor can result in damage to the generator rotating components.

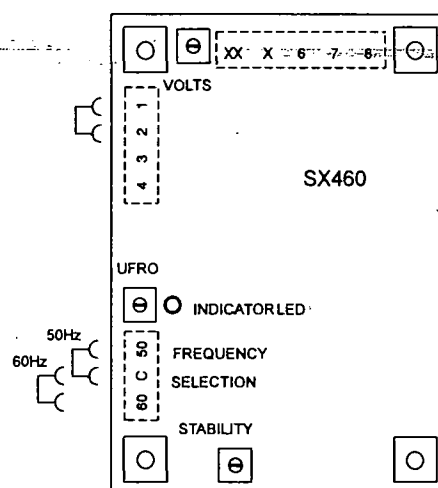
In addition remove the AVR access cover (on AVR controlled generators) and turn VOLTS control fully anti-clockwise. Start the generating set and run on no-load at nominal frequency. Slowly turn VOLTS control potentiometer clockwise until rated voltage is reached. Refer to Fig. 6a, 6b, 6c, 6d or 6e for control potentiometer location.

**Important !** Do not increase the voltage above the rated generator voltage shown on the generator nameplate.

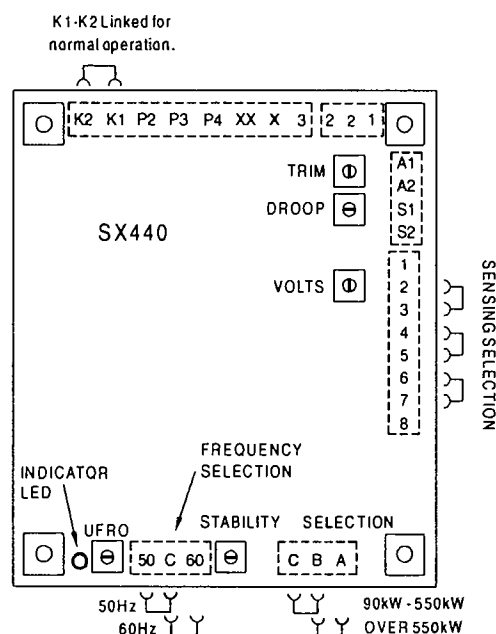
The STABILITY control potentiometer will have been pre-set and should normally not require adjustment, but should this be required, usually identified by oscillation of the voltmeter, refer to Fig. 6a, 6b, 6c, 6d or 6e for control potentiometer location and proceed as follows:-

1. Run the generating set on no-load and check that speed is correct and stable
2. Turn the STABILITY control potentiometer clockwise, then turn slowly anti-clockwise until the generator voltage starts to become unstable.

The correct setting is slightly clockwise from this position (i.e. where the machine volts are stable but close to the unstable region).



**Fig. 6a**



**Fig. 6b**

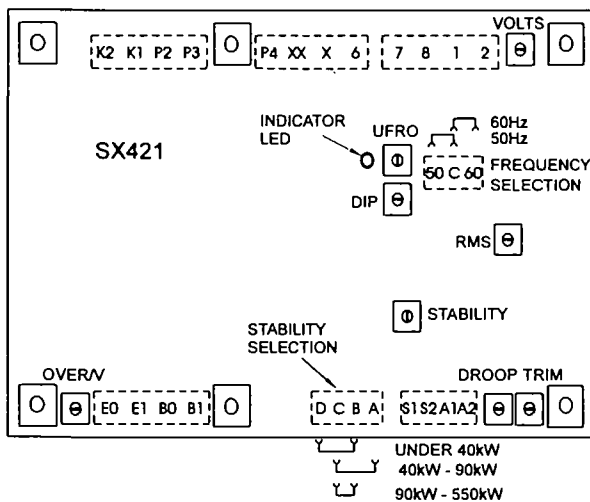


Fig. 6c

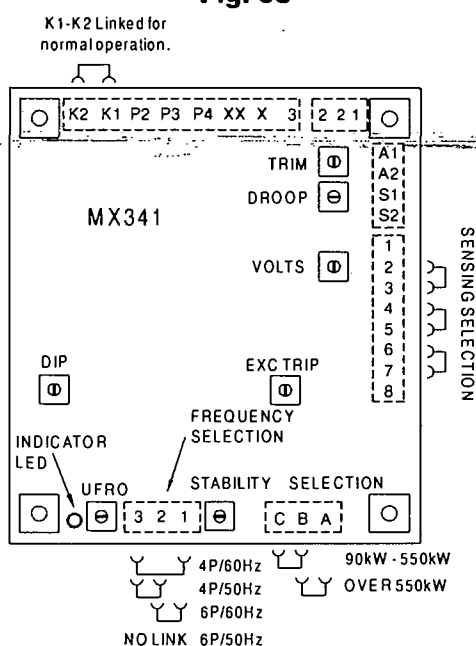


Fig. 6d

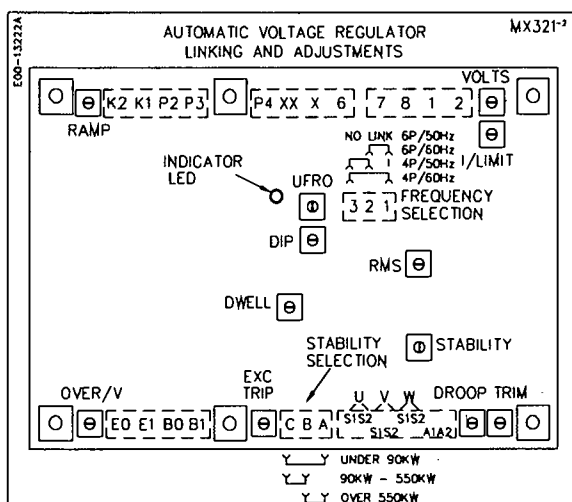


Fig. 6e

## 4.7 LOAD TESTING



### Warning !

During testing it may be necessary to remove covers to adjust controls exposing 'live' terminals or components. Only personnel qualified to perform electrical service should carry out testing and/or adjustments. Refit all access covers after adjustments are completed.

### 4.7.1 AVR CONTROLLED GENERATORS - AVR ADJUSTMENTS

Refer to Fig. 6a, 6b, 6c, 6d or 6e for control potentiometer locations.

Having adjusted VOLTS and STABILITY during the initial start-up procedure, other AVR control functions should not normally need adjustment.

If however, poor voltage regulation on-load or voltage collapse is experienced, refer to the following paragraphs on each function to a) check that the symptoms observed do indicate adjustment is necessary, and b) to make the adjustment correctly.

#### 4.7.1.1 UFRO (Under Frequency Roll Off) (AVR Types SX460, SX440, SX421, MX341 and MX321)

The AVR incorporates an underspeed protection circuit which gives a voltage/speed (Hz) characteristic as shown:

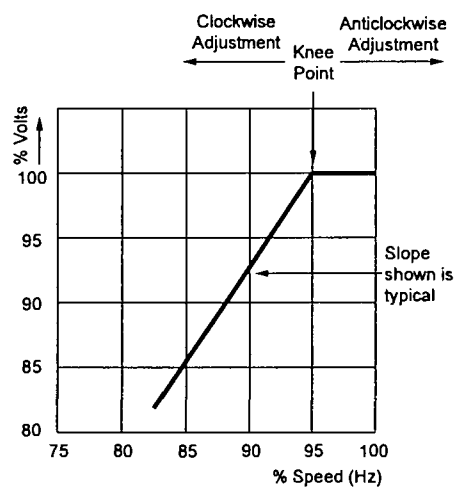


Fig. 7

The UFRO control potentiometer sets the "knee point".

Symptoms of incorrect setting are a) the light emitting diode (LED) indicator, just above the UFRO Control potentiometer, being permanently lit when the generator is on load, and b) poor voltage regulation on load, i.e. operation on the sloping part of the characteristic.

Clockwise adjustment lowers the frequency (speed) setting of the "knee point" and extinguishes the LED. For Optimum setting the LED should illuminate as the frequency falls just below nominal frequency, i.e. 47Hz on a 50Hz generator or 57Hz on a 60Hz generator.

**Important !** With AVR Types MX341 and MX321: If the LED is illuminated and no output voltage is present, refer to EXC TRIP and/or OVER/V sections below.

#### 4.7.1.2 EXC TRIP (Excitation Trip) AVR Types MX341 and MX321

An AVR supplied from a permanent magnet generator inherently delivers maximum excitation power on a line to line or line to neutral short circuit or large overload. In order to protect the generator windings the AVR incorporates an over excitation circuit which detects high excitation and removes it after a pre-determined time, i.e. 8-10 seconds.

Symptoms of incorrect setting are the generator output collapses on load or small overload, and the LED is permanently illuminated.

The correct setting is 70 volts  $\pm$  5% between terminals X and XX.

#### 4.7.1.3 OVER/V (Over Voltage) AVR Type SX421, MX321

Over voltage protection circuitry is included in the AVR to remove generator excitation in the event of loss of AVR sensing input.

The MX321 has both internal electronic de-excitation and provision of a signal to operate an external circuit breaker.

The SX421 only provides a signal to operate an external breaker, which **MUST** be fitted if over voltage protection is required.

Incorrect setting would cause the generator output voltage to collapse at no-load or on removal of load, and the LED to be illuminated.

The correct setting is 300 volts  $\pm$  5% across terminals E1, E0. Clockwise adjustment of the OVER/V control potentiometer will increase the voltage at which the circuit operates.

#### 4.7.1.4 TRANSIENT LOAD SWITCHING ADJUSTMENTS AVR Types SX421, MX341 and MX321

The additional function controls of DIP and DWELL are provided to enable the load acceptance capability of the generating set to be optimised. The overall generating set performance depends upon the engine capability and governor response, in conjunction with the generator characteristics.

It is not possible to adjust the level of voltage dip or recovery independently from the engine performance, and there will always be a 'trade off' between frequency dip and voltage dip.

#### DIP

##### AVR Types SX421, MX341 and MX321

AVR Types SX421, MX341 and MX321

The dip function control potentiometer adjusts the slope of the voltage/speed (Hz) characteristic below the knee point as shown below:

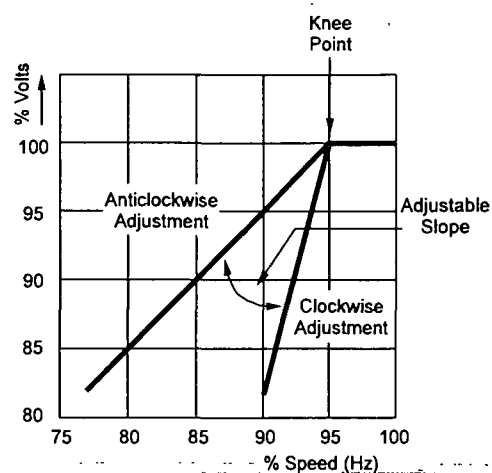


Fig. 8

#### DWELL

##### AVR Type MX321

The dwell function introduces a time delay between the recovery of voltage and recovery of speed.

The purpose of the time delay is to reduce the generator kW below the available engine kW during the recovery period, thus allowing an improved speed recovery.

Again this control is only functional below the "knee point", i.e. if the speed stays above the knee point during load switching there is no effect from the DWELL function setting.

Clockwise adjustment gives increased recovery time.

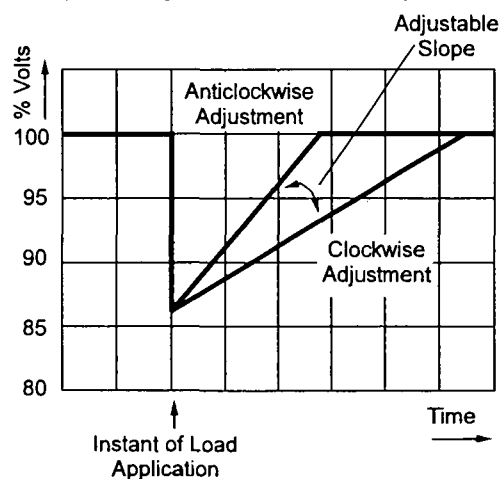


Fig. 9

The graphs shown above are representations only, since it is impossible to show the combined effects of voltage regulator and engine governor performance.

#### 4.7.1.5 RAMP

##### AVR Type MX321

The RAMP potentiometer enables adjustment of the time taken for the generator's initial build up to normal rated voltage during each start and run up to speed. The potentiometer is factory set to give a ramp time of three seconds, which is considered to be suitable for most applications. This time can be reduced to one second by turning the pot. fully counter clockwise, and increased to eight seconds by turning the pot. fully clockwise.

#### 4.7.2 TRANSFORMER CONTROLLED GENERATORS - TRANSFORMER ADJUSTMENT

Normally no adjustment is required but should the no-load voltage and/or on-load voltage be unacceptable, adjustment of the transformer air gap can be made as follows.

Stop the generator. Remove transformer cover box. (Normally left hand side of the terminal box when viewed from the non drive end).

Slacken the three transformer mounting bolts along the top of the transformer.

Start the set with a voltmeter connected across the main output terminals.

Adjust the air gap between the transformer top lamination section and the transformer limbs to obtain required voltage on no-load. Slightly tighten the three mounting bolts. Switch load 'on' and 'off' two or three times. Application of load will normally raise the voltage setting slightly. With the load 'off' recheck the no-load voltage.

Readjust air gap and finally tighten mounting bolts.

Refit the access cover.



**Warning !**

Failure to refit covers can result in operator personal injury or death.

#### 4.8 ACCESSORIES

Refer to the "ACCESSORIES" - Section 6 of this Manual for setting up procedures related to generator mounted accessories.

If there are accessories for control panel mounting supplied with the generator refer to the specific accessory fitting procedures inserted inside the back cover of this book.

## SECTION 5

### INSTALLATION - PART 2

#### 5.1 GENERAL

The extent of site installation will depend upon the generating set build, e.g. if the generator is installed in a canopied set with integral switchboards and circuit breaker, on site installation will be limited to connecting up the site load to the generating set output terminals. In this case reference should be made to the generating set manufacturer's instruction book and any pertinent local regulations.

If the generator has been installed on a set without switchboard or circuit breaker the following points relating to connecting up the generator should be noted.

#### 5.2 GLANDING

The terminal box is most conveniently glanded on either the right or left hand side. Both panels are removable for drilling/punching to suit glands/or glanding boxes. If single core cables are taken through the terminal box side panel an insulated or non-magnetic gland plate should be fitted.

Incoming cables should be supported from either below or above the box level and at a sufficient distance from the centre line of the generating set so as to avoid a tight radius at the point of entry into the terminal box panel, and allow movement of the generator set on its anti-vibration mountings without excessive stress on the cable.

Before making final connections, test the insulation resistance of the windings. The AVR should be disconnected during this test.

A 500V Megger or similar instrument should be used. Should the insulation resistance be less than  $5M\Omega$  the windings must be dried out as detailed in the Service and Maintenance section of this manual.

When making connections to the terminals the incoming cable termination should be placed on top of the winding lead termination(s) and clamped with the nut provided.

**Important ! To avoid the possibility of swarf entering any electrical components in the terminal box, panels must be removed for drilling.**

#### 5.3 EARTHING

The neutral of the generator is not bonded to the generator frame as supplied from the factory. An earth terminal is provided inside the terminal box adjacent to the main terminals. Should it be required to operate with the neutral earthed a substantial earth conductor (normally equivalent to one half of the section of the line conductors) must be connected between the neutral and the earth terminal inside the terminal box. Additional earth terminals are provided on the generator feet. These should be already bonded to the generating set bedplate by the generating set builder, but will normally be required to be connected to the site earth system.

**Caution ! Reference to local electricity regulations or safety rules should be made to ensure correct earthing procedures have been followed.**

#### 5.4 PROTECTION

It is the responsibility of the end user and his contractors/sub-contractors to ensure that the overall system protection meets the needs of any inspectorate, local electricity authority or safety rules, pertaining to the site location.

To enable the system designer to achieve the necessary protection and/or discrimination, fault current curves are available on request from the factory, together with generator reactance values to enable fault current calculations to be made.



**Warning !**

**Incorrect installation and/or protective systems can result in personal injury and/or equipment damage. Installers must be qualified to perform electrical installation work.**

#### 5.5 COMMISSIONING

Ensure that all external cabling is correct and that all the generating set manufacturer's pre-running checks have been carried out before starting the set.

The generator AVR controls will have been adjusted during the generating set manufacturer's tests and should normally not require further adjustment.

Should malfunction occur during commissioning refer to Service and Maintenance section 'Fault Finding' procedure (subsection 7.4).

## SECTION 6

### ACCESSORIES

Generator control accessories may be fitted, as an option, in the generator terminal box. If fitted at the time of supply, the wiring diagram(s) in the back of this book shows the connections. When the options are supplied separately, fitting instructions are provided with the accessory.

The following matrix indicates availability of accessories with the differing AVRs.

Note the SX460 is not suitable for operation with accessories.

| AVR Model | Parallel Droop or Astatic | Manual Voltage Regulator | VAr/PF Control | Current Limit |
|-----------|---------------------------|--------------------------|----------------|---------------|
| SX440     | ✓                         | ✗                        | ✓              | ✗             |
| SX421     | ✓                         | ✗                        | ✓              | ✗             |
| MX341     | ✓                         | ✓                        | ✓              | ✗             |
| MX321     | ✓                         | ✓                        | ✓              | ✓             |

#### 6.1 REMOTE VOLTAGE ADJUST (ALL AVR TYPES)

A remote voltage adjust (hand trimmer) can be fitted.

**SX460** Remove link 1-2 on the AVR and connect adjuster to terminals 1 and 2.

**SX440, SX421** Remove link 1-2 at the auxiliary terminals  
**MX341 and MX321** and connect adjuster to terminals 1 and 2.

#### 6.2 PARALLEL OPERATION

Understanding of the following notes on parallel operation is useful before attempting the fitting or setting of the droop kit accessory. When operating in parallel with other generators or the mains, it is essential that the phase sequence of the incoming generator matches that of the busbar and also that all of the following conditions are met before the circuit breaker of the incoming generator is closed on to the busbar (or operational generator).

1. Frequency must match within close limits.
2. Voltages must match within close limits.
3. Phase angle of voltages must match within close limits. A variety of techniques, varying from simple synchronising lamps to fully automatic synchronisers, can be used to ensure these conditions are met.

**Important !** Failure to meet conditions 1, 2, and 3 when closing the circuit breaker, will generate excessive mechanical and electrical stresses, resulting in equipment damage.

Once connected in parallel a minimum instrumentation level per generator of voltmeter, ammeter, wattmeter (measuring total power per generator), and frequency meter is required in order to adjust the engine and generator controls to share kW in relation to engine ratings and kVAr in relation to generator ratings.

It is important to recognise that:

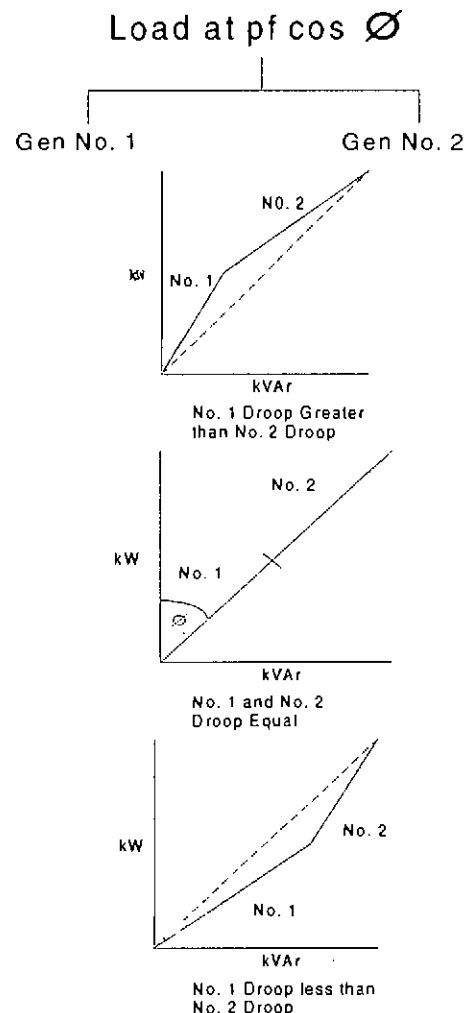
1. True kW are derived from the engine, and speed governor characteristics determine the kW sharing between sets
- and
2. kVAr are derived from the generator, and excitation control characteristics determine the kVAr sharing. Reference should be made to the generating set manufacturer's instructions for setting the governor controls.

#### 6.2.1 DROOP

The most commonly used method of kVAr sharing is to create a generator voltage characteristic which falls with decreasing power factor (increasing kVAr). This is achieved with a current transformer (C.T.) which provides a signal dependent on current phase angle (i.e. power factor) to the AVR.

The current transformer has a burden resistor on the AVR board, and a percentage of the burden resistor voltage is summed into the AVR circuit. Increasing droop is obtained by turning the DROOP control potentiometer clockwise.

The diagrams below indicate the effect of droop in a simple two generator system:-



Generally 5% droop at full load current zero p.f. is sufficient to ensure kVAR sharing.

If the droop accessory has been supplied with the generator it will have been tested to ensure correct polarity and set to a nominal level of droop. The final level of droop will be set during generating set commissioning.

The following setting procedure will be found to be helpful.

### 6.2.1.1 SETTING PROCEDURE

Depending upon available load the following settings should be used - all are based on rated current level.

|                |                        |                 |
|----------------|------------------------|-----------------|
| 0.8 P.F. LOAD  | (at full load current) | SET DROOP TO 3% |
| Zero P.F. LOAD | (at full load current) | SET DROOP TO 5% |

Setting the droop with low power factor load is the most accurate. Run each generator as a single unit at rated frequency or rated frequency + 4% depending upon type of governor and nominal voltage. Apply available load to rated current of the generator. Adjust 'DROOP' control potentiometer to give droop in line with above table. Clockwise rotation increases amount of droop. Refer to Fig 9a, 9b, 9c or 9d for potentiometer locations.

#### Note 1)

Reverse polarity of the C.T. will raise the generator voltage with load. The polarities S1-S2 shown on the wiring diagrams are correct for clockwise rotation of the generator looking at the drive end. Reversed rotation requires S1-S2 to be reversed.

#### Note 2)

The most important aspect is to set all generators equal. The precise level of droop is less critical.

#### Note 3)

A generator operated as a single unit with a droop circuit set at rated load 0.8 power factor is unable to maintain the usual +/- 0.5% regulation. A shorting switch can be connected across S1-S2 to restore regulation for single running.

**Important ! LOSS OF FUEL to an engine can cause its generator to motor with consequent damage to the generator windings. Reverse power relays should be fitted to trip main circuit breaker. LOSS OF EXCITATION to the generator can result in large current oscillations with consequent damage to generator windings. Excitation loss detection equipment should be fitted on trip main circuit breaker.**

### 6.2.2 ASTATIC CONTROL

The 'droop' current transformer can be used in a connection arrangement which enables the normal regulation of the generator to be maintained when operating in parallel.

This feature is only supplied from the factory as a fitted droop kit, however, if requested at the time of order, the diagrams inside the back cover of this book will give the necessary site connections. The end user is required to provide a shorting switch for the droop current transformer secondary.

Should the generator be required to be converted from standard droop to 'astatic' control, diagrams are available on request.

The setting procedure is exactly the same as for DROOP. (Subsection 6.2.1.1)

**Important ! When using this connection arrangement a shorting switch is required across each C.T. burden (terminals S1 and S2.) The switch must be closed a) when a generating set is not running and b) when a generating set is selected for single running.**

### 6.3 MANUAL VOLTAGE REGULATOR (MVR) - MX341 and MX321 AVR

This accessory is provided as an 'emergency' excitation system, in the event of an AVR failure.

Powered from the PMG output the unit is manually set, but automatically controls the excitation current, independent of generator voltage or frequency.

The unit is provided with 'MANUAL', 'OFF', 'AUTO' switching facility.

#### 'MANUAL'

- position connects the exciter field to the MVR output. Generator output is then controlled by the operator adjusting the excitation current.

#### 'OFF'

- disconnects the exciter field from both MVR and the normal AVR.

#### 'AUTO'

- connects the exciter field to the normal AVR and the generator output is controlled at the pre-set voltage under AVR control.

Switching mode of operation should be carried out with the generator set stationary to avoid voltage surges on the connected load, although neither the MVR nor AVR will be damaged should the switching be carried out with the set running.

### 6.4 OVERVOLTAGE DE-EXCITATION BREAKER SX421 and MX321 AVR

This accessory provides positive interruption of the excitation power in the event of overvoltage due to loss of sensing or internal AVR faults including the output power device.

With the MX321 AVR this accessory is supplied loose for fitting in the control panel.

In the case of the SX421 the circuit breaker is always supplied and will normally be fitted in the generator.

**Important ! When the circuit breaker is supplied loose, the AVR is fitted with a link on terminals K1-K2 to enable operation of the AVR. When connecting the circuit breaker this link must be removed.**

### 6.4.1 RESETTING THE BREAKER

In the event of operation of the circuit breaker, indicated by loss of generator output voltage, manual resetting is required. When in the "tripped" state the circuit breaker switch lever shows "OFF". To reset move the switch lever to the position showing "ON".

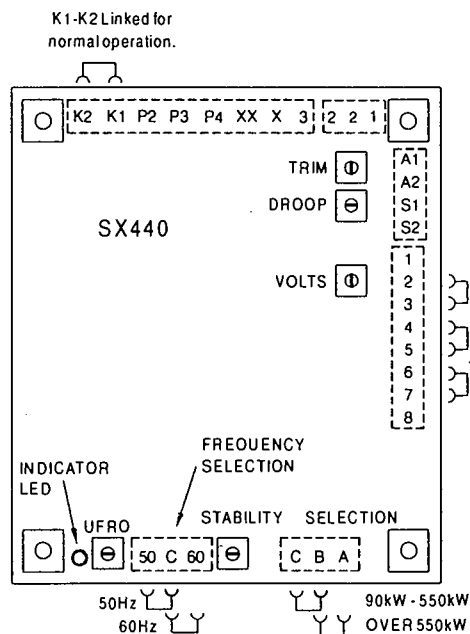
When fitted in the generator, access to the breaker is gained by removal of the AVR access cover.



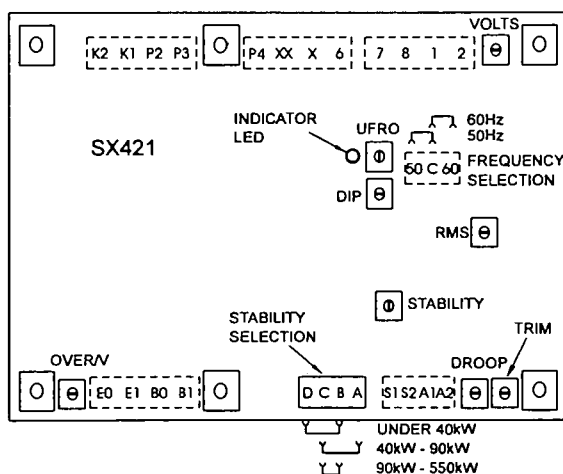
**Danger !**

Terminals which are **LIVE** with the generating set running are exposed when the AVR access cover is removed. Resetting of the circuit breaker **MUST** be carried out with the generating set stationary, and engine starting circuits disabled.

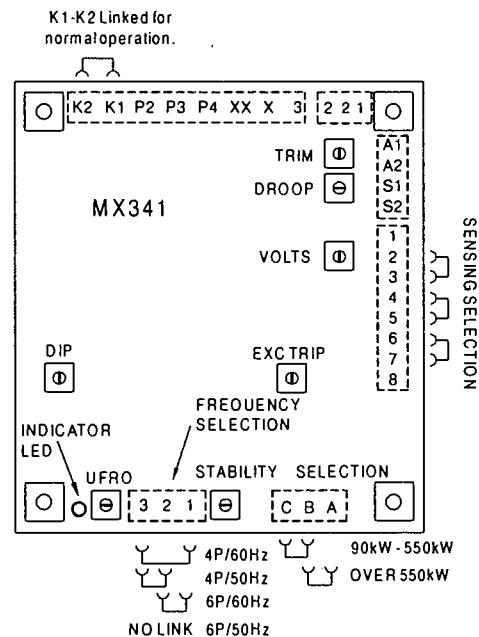
The circuit breaker is mounted on the AVR mounting bracket either to the left or to the right of the AVR depending upon AVR position. After resetting the circuit breaker replace the AVR access cover before restarting the generating set. Should resetting of the circuit breaker not restore the generator to normal operation, refer to subsection 7.5.



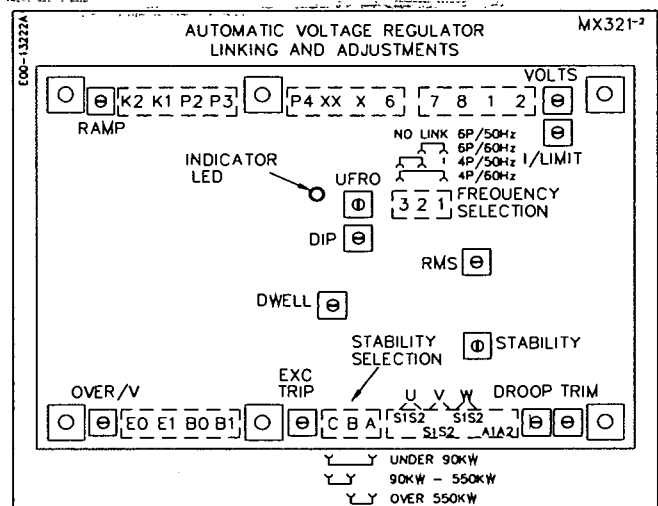
**Fig. 9a**



**Fig. 9b**



**Fig. 9c**



**Fig. 9d**

### 6.5 CURRENT LIMIT - MX321 AVR

These accessories work in conjunction with the AVR circuits to provide an adjustment to the level of current delivered into a fault. One current transformer (CT) per phase is fitted to provide current limiting on any line to line or line to neutral fault.

Note: The W phase CT can also provide "DROOP". Refer to 6.2.1.1 for setting droop independent of current limit.

Adjustment means is provided with the "I/LIMIT" control potentiometer on the AVR. Refer to Fig. 9d for location. If current limit transformers are supplied with the generator the limit will be set in accordance with the level specified at the time of order, and no further adjustment will be necessary. However, should the level need to be adjusted, refer to the setting procedure given in 6.5.1.

#### 6.5.1 SETTING PROCEDURE

Run the generating set on no-load and check that engine governor is set to control nominal speed.

Stop the generating set. Remove the link between terminals K1-K2 at the auxiliary terminal block and connect a 5A switch across the terminals K1-K2.

Turn the "I/LIMIT" control potentiometer fully anticlockwise. Short circuit the stator winding with a bolted 3 phase short at the main terminals. An AC current clip-on ammeter is required to measure the winding lead current.

With the switch across K1-K2 open start the generating set.

Close the switch across K1-K2 and turn the "I/LIMIT" control potentiometer clockwise until required current level is observed on the clip-on ammeter. As soon as correct setting is achieved open the K1-K2 switch.

Should the current collapse during the setting procedure, the internal protective circuits of the AVR will have operated. In this event shut down the set and open the K1-K2 switch. Restart the set and run for 10 minutes with K1-K2 switch open, to cool the generator windings, before attempting to resume the setting procedure.

**Important ! Failure to carry out the correct COOLING procedure, may cause overheating and consequent damage to the generator windings.**

## 6.6 POWER FACTOR CONTROLLER (PFC3)

This accessory is primarily designed for those generator applications where operation in parallel with the mains supply is required.

Protection against loss of mains voltage or generator excitation is not included in the unit and the system designer must incorporate suitable protection.

The electronic control unit requires both droop and kVAr current transformers. When supplied with the generator, wiring diagrams inside the back cover of this manual show the connections and the additional instruction leaflet provided gives details of setting procedures for the power factor controller (PFC3).

The unit monitors the power factor of the generator current and adjusts excitation to maintain the power factor constant.

This mode can also be used to control the power factor of the mains if the point of current monitoring is moved to the mains cables. Refer to the factory for appropriate details.

It is also possible to operate the unit to control kVAr of the generator if required. Refer to the factory for appropriate details.

## SECTION 7

### SERVICE AND MAINTENANCE

As part of routine maintenance procedures, periodic attention to winding condition (particularly when generators have been idle for a long period) and bearings is recommended. (Refer to subsections 7.1 and 7.2 respectively).

When generators are fitted with air filters regular inspection and filter maintenance is required. (Refer to subsection 7.3).

#### 7.1 WINDING CONDITION



**Warning !**

**Service and fault finding procedures present hazards which can result in severe personal injury or death. Only personnel qualified to perform electrical and mechanical service should carry out these procedures. Ensure engine starting circuits are disabled before commencing service or maintenance procedures. Isolate any anti-condensation heater supply.**

#### Guidance of Typical Insulation Resistance [IR] Values

The following is offered as general information about IR values and is aimed at providing guidance about the typical IR values for generators from new through to the point of refurbishment.

##### New Machines

The generators Insulation Resistance, along with many other critical factors, will have been measured during the alternator manufacturing process. The generator will have been transported with an appropriate packaging suitable for the method of delivery to the Generating Set assemblers works. Where we expect it to be stored in a suitable location protected from adverse environmental conditions.

However, absolute assurance that the generator will arrive at the Gen-set production line with IR values still at the factory test levels of above 100 MΩ cannot be guaranteed.

##### At Generating Set Manufacturers Works

The generator should have been transported and stored such that it will be delivered to the assembly area in a clean dry condition. If held in appropriate storage conditions the generator IR value should typically be 25 MΩ.

If the unused/new generators IR values fall below 10 MΩ then a drying out procedure should be implemented by one of the processes outlined below before being despatched to the end customer's site. Some investigation should be undertaken into the storage conditions of the generator while on site.

##### Generators in Service

Whilst It is known that a generator will give reliable service with an IR value of just 1.0 MΩ. For a relatively new generator to be so low it must have been subjected to inappropriate operating or storage conditions.

Any temporarily reduction in IR values can be restored to expected values by following one of the drying out procedures.

#### 7.1.1 WINDING CONDITION ASSESSMENT

**Caution ! The AVR should be disconnected and the Resistance Temperature Detector (R.T.D.) leads grounded during this test.**

The condition of the windings can be assessed by measurement of insulation resistance [IR] between phase to phase, and phase to earth.

Measurement of winding insulation should be carried out: -

1. As part of a periodic maintenance plan.
2. After prolonged periods of shutdown.
3. When low insulation is suspected, e.g. damp or wet windings.

Care should be taken when dealing with windings that are suspected of being excessively damp or dirty. The initial measurement of the [IR] Insulation Resistance should be established using a low voltage (500V) megger type instrument. If manually powered the handle should initially be turned slowly so that the full test voltage will not be applied, and only applied for long enough to very quickly assess the situation if low values are suspected or immediately indicated.

Full megger tests or any other form of high voltage test should not be applied until the windings have been dried out and if necessary cleaned.

##### Procedure for Insulation Testing

Disconnect all electronic components, AVR, electronic protection equipment etc. Ground the [RTD's] Resistance Temperature Detection devices if fitted. Short out the diodes on the rotating diode assembly. Be aware of all components connected to the system under test that could cause false readings or be damaged by the test voltage.

Carry out the insulation test in accordance with the 'operating instructions for the test equipment.

The measured value of insulation resistance for all windings to earth and phase to phase should be compared with the guidance given above for the various 'life stages' of a generator. The minimum acceptable value must be greater than 1.0 MΩ.

**If low winding insulation is confirmed use one or more of the methods, given below, for drying the winding should be carried out.**

#### 7.1.2 METHODS OF DRYING OUT GENERATORS

##### Cold Run

Consider a good condition generator that has not been run for some time, and has been standing in damp, humid conditions. It is possible that simply running the gen set unexcited - AVR terminals K1 K2 open circuit - for a period of say 10 minutes will sufficiently dry the surface of the windings and raise the IR sufficiently, to greater than 1.0 MΩ, and so allow the unit to be put into service.

## Blown Air Drying

Remove the covers from all apertures to allow the escape of the water-laden air. During drying, air must be able to flow freely through the generator in order to carry off the moisture.

Direct hot air from two electrical fan heaters of around 1 – 3 kW into the generator air inlet apertures. Ensure the heat source is at least 300mm away from the windings to avoid over heating and damage to the insulation.

Apply the heat and plot the insulation value at half hourly intervals. The process is complete when the parameters covered in the section entitled, 'Typical Drying Out Curve', are met.

Remove the heaters, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anti-condensation heaters are energised, and retest prior to running.

## Short Circuit Method

**NOTE:** This process should only be performed by a competent engineer familiar with safe operating practices within and around generator sets of the type in question.

Ensure the generator is safe to work on, initiate all mechanical and electrical safety procedures pertaining to the genset and the site.

Bolt a short circuit of adequate current carrying capacity, across the main terminals of the generator. The shorting link should be capable of taking full load current.

Disconnect the cables from terminals "X" and "XX" of the AVR.

Connect a variable dc supply to the "X" (positive) and "XX" (negative) field cables. The dc supply must be able to provide a current up to 2.0 Amp at 0 - 24 Volts.

Position a suitable ac ammeter to measure the shorting link current.

Set the dc supply voltage to zero and start the generating set. Slowly increase the dc voltage to pass current through the exciter field winding. As the excitation current increases, so the stator current in the shorting link will increase. This stator output current level must be monitored, and not allowed to exceed 80% of the generators rated output current.

After every 30 minutes of this exercise:

Stop the generator and switch off the separate excitation supply, and measure and record the stator winding IR values, and plot the results. The resulting graph should be compared with the classic shaped graph. This drying out procedure is complete when the parameters covered in the section entitled 'Typical Drying Out Curve' are met.

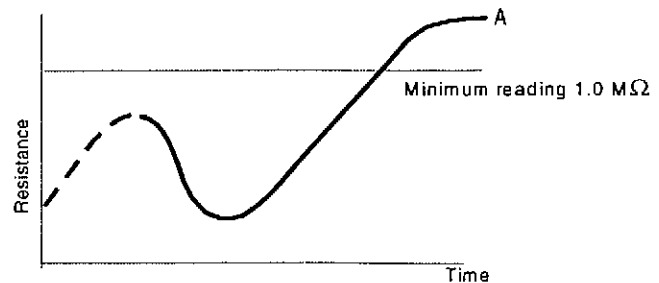
Once the Insulation Resistance is raised to an acceptable level - minimum value 1.0 MΩ – the dc supply may be removed and the exciter field leads "X" and "XX" re-connected to their terminals on the AVR.

Rebuild the genset, replace all covers and re-commission as appropriate.

If the set is not to be run immediately ensure that the anti-condensation heaters are energised, and retest the generator prior to running.

## TYPICAL DRYING OUT CURVE

Whichever method is used to dry out the generator the resistance should be measured every half-hour and a curve plotted as shown. (fig 6.)



**Fig. 9**

The illustration shows a typical curve for a machine that has absorbed a considerable amount of moisture. The curve indicates a temporary increase in resistance, a fall and then a gradual rise to a steady state. Point 'A', the steady state, must be greater than 1.0 MΩ. (If the windings are only slightly damp the dotted portion of the curve may not appear).

For general guidance expect that the typical time to reach point 'A' will be:

- 1 hour for a BC16/18,
- 2 hours for a UC22/27
- 3 hours for an HC4,5,6&7

Drying should be continued after point "A" has been reached for at least one hour.

It should be noted that as winding temperature increases, values of insulation resistance may significantly reduce. Therefore, the reference values for insulation resistance can only be established with windings at a temperature of approximately 20°C.

If the IR value remains below 1.0 MΩ, even after the above drying methods have been properly conducted, then a Polarisation Index test [PI] should be carried out.

If the minimum value of 1.0 MΩ for all components cannot be achieved rewinding or refurbishment of the generator will be necessary.

**The generator must not be put into service until the minimum values can be achieved.**

**Important ! The short circuit must not be applied with the AVR connected in circuit. Current in excess of the rated generator current will cause damage to the windings.**

After drying out, the insulation resistances should be rechecked to verify minimum resistances quoted above are achieved.

On re-testing it is recommended that the main stator insulation resistance is checked as follows:-

Separate the neutral leads

|        |         |                  |                   |
|--------|---------|------------------|-------------------|
| Ground | V and W | phase and megger | U phase to ground |
| Ground | U and W | phase and megger | V phase to ground |
| Ground | U and V | phase and megger | W phase to ground |

If the minimum value of 1.0MΩ is not obtained, drying out must be continued and the test repeated.

## 7.2 BEARINGS

All bearings are supplied sealed for life and are, therefore, not regreaseable.

**Important !** The life of a bearing in service is subject to the working conditions and the environment.

**Important !** Long stationary periods in an environment where there is vibration can cause false brinnelling which puts flats on the ball and grooves on the races.  
Very humid atmospheres or wet conditions can emulsify the grease and cause corrosion.

**Important !** High axial vibration from the engine or misalignment of the set will stress the bearing.

The bearing, in service, is affected by a variety of factors that together will determine the bearing life. We recommend that the health of the bearings be monitored, using 'spike energy' vibration monitoring equipment. This will allow the timely replacement of bearings, that exhibit a deteriorating trend, during a major engine overhaul.

If excessive heat, noise or vibration is detected, change the bearing as soon as practicable. Failure to do so could result in bearing failure.


In the event that 'spike energy' vibration monitoring equipment is not available, it is strongly recommend that consideration be given to changing the bearing during each 'major engine overhaul'.

Belt driven application will impose an additional load on bearings. The bearing life will therefore be significantly affected. It is important that the side load limits given in SECTION 3 are not exceeded and the health of the bearing is monitored more closely.

## 7.3 AIR FILTERS

The frequency of filter maintenance will depend upon the severity of the site conditions. Regular inspection of the elements will be required to establish when cleaning is necessary.

### 7.3.1 CLEANING PROCEDURE

|  |  |
|--|--|
|  <p><b>Danger !</b></p> | <p><b>Removal of filter elements enables access to LIVE parts.</b></p> <p><b>Only remove elements with the generator out of service.</b></p> |
|--|--|

Remove the filter elements from the filter frames. Immerse or flush the element with a suitable detergent until the element is clean. Dry elements thoroughly before refitting.

## 7.4 FAULT FINDING

**Important !** Before commencing any fault finding procedure examine all wiring for broken or loose connections.

Four types of excitation control system, involving four types of AVR, can be fitted to the range of generators covered by this manual. The systems can be identified by a combination of AVR type, where applicable, and the last digit of the generator frame size designation. Refer to the generator nameplate then proceed to the appropriate subsection as indicated below:-

| DIGIT | EXCITATION CONTROL  | SUBSECTION |
|-------|---------------------|------------|
| 6     | SX460 AVR           | 7.4.1      |
| 4     | SX440 AVR           | 7.4.2      |
| 4     | SX421 AVR           | 7.4.3      |
| 5     | Transformer control | 7.4.4      |
| 3     | MX341 AVR           | 7.4.5      |
| 3     | MX321 AVR           | 7.4.6      |

### 7.4.1 SX460 AVR - FAULT FINDING

|   |  |
|---|--|
| No voltage build-up when starting set           | <ol style="list-style-type: none"> <li>1. Check speed</li> <li>2. Check residual voltage. Refer to subsection 7.4.7.</li> <li>3. Follow Separate Excitation Test Procedure to check generator and AVR.</li> </ol>                    |
| Unstable voltage either on no-load or with load | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check stability setting. Refer to subsection 4.6.</li> </ol>  |
| High voltage either on no-load or with load     | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check that generator load is not capacitive (leading power factor).</li> </ol>  |
| Low voltage no-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check link 1-2 or external hand trimmer leads for continuity.</li> </ol>  |
| Low voltage on-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check UFRO setting. Refer to subsection 4.7.1.1.</li> <li>3. Follow Separate Excitation Procedure to check generator and AVR. Refer to subsection 7.5.</li> </ol> |

**7.4.2 SX440 AVR - FAULT FINDING**

|  |  |
|--|--|
| No voltage build-up when starting set.           | <ol style="list-style-type: none"> <li>1. Check link K1-K2 on auxiliary terminals.</li> <li>2. Check speed.</li> <li>3. Check residual voltage. Refer to subsection 7.4.7.</li> <li>4. Follow Separate Excitation Test Procedure to check generator and AVR. Refer to subsection 7.5.</li> </ol> |
| Unstable voltage either on no-load or with load. | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check stability setting. Refer to subsection 4.6.</li> </ol>  |
| High voltage either on no-load or with load      | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check that generator load is not capacitive (leading power factor).</li> </ol>  |
| Low voltage no-load                              | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check link 1-2 or external hand trimmer leads for continuity.</li> </ol>  |
| Low voltage on-load                              | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check UFRO setting. Refer to subsection 4.7.1.1.</li> <li>3. Follow Separate Excitation Procedure to check generator and AVR. Refer to subsection 7.5.</li> </ol>   |

**7.4.3 SX421 AVR - FAULT FINDING**

|   |   |
|---|---|
| No voltage build-up when starting set           | <ol style="list-style-type: none"> <li>1. Check circuit breaker 'ON'. Refer to subsection 6.4.1.</li> <li>2. Check speed.</li> <li>3. Check residual voltage. Refer to subsection 7.4.7.</li> <li>4. Follow Separate Excitation Procedure to check generator and AVR. Refer to subsection 7.5.</li> </ol> |
| Unstable voltage either on no-load or with load | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check stability setting. Refer to subsection 4.6.</li> </ol>   |
| High voltage either on no-load or with load     | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check link 1-2 or external hand trimmer leads for continuity. Check continuity of leads 7-8 and P3-P2 for continuity.</li> <li>3. Check that generator load is not capacitive (leading power factor).</li> </ol>                       |
| Low voltage no-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check link 1-2 or external hand trimmer leads for continuity.</li> </ol>   |

|   |  |
|---|--|
| Low voltage on-load                           | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check UFRO setting. Refer to subsection 4.7.1.1.</li> <li>3. Follow Separate Excitation to check generator and AVR. Refer to subsection 7.5.</li> </ol> |
| Excessive voltage/speed dip on-load switching | <ol style="list-style-type: none"> <li>1. Check governor response.</li> <li>2. Refer to generating set manual. Check 'DIP' setting. Refer to subsection 4.7.1.4.</li> </ol>  |

**7.4.4 TRANSFORMER CONTROL - FAULT FINDING**

|                                       |  |
|---------------------------------------|--|
| No voltage build-up when starting set | <ol style="list-style-type: none"> <li>1. Check transformers rectifiers.</li> <li>2. Check transformer secondary winding for open circuit.</li> </ol>  |
| Low voltage                           | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check transformer air gap setting. Refer to subsection 4.7.2.</li> </ol>  |
| High voltage                          | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. Check transformer air gap setting. Refer to subsection 4.7.2.</li> <li>3. Check transformer secondary winding for short circuited turns.</li> </ol> |
| Excessive voltage drop on-load        | <ol style="list-style-type: none"> <li>1. Check speed drop on-load.</li> <li>2. Check transformer rectifiers. Check transformer air gap setting. Refer to subsection 4.7.2.</li> </ol>                                 |

**7.4.5 MX341 AVR - FAULT FINDING**

|   |  |
|---|--|
| No voltage build-up when starting set           | <ol style="list-style-type: none"> <li>1. Check link K1-K2 on auxiliary terminals.</li> <li>2. Follow Separate Excitation Test Procedure to check machine and AVR. Refer to subsection 7.5.</li> </ol>     |
| Loss of voltage when set running                | <ol style="list-style-type: none"> <li>1. First stop and re-start set. If no voltage or voltage collapses after short time, follow Separate Excitation Test Procedure. Refer to subsection 7.5.</li> </ol> |
| Generator voltage high followed by collapse     | <ol style="list-style-type: none"> <li>1. Check sensing leads to AVR.</li> <li>2. Refer to Separate Excitation Test Procedure. Refer to subsection 7.5.</li> </ol>   |
| Voltage unstable either on no-load or with load | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check "STAB" setting. Refer to Load Testing section for procedure. Refer to subsection 4.6.</li> </ol>                        |
| Low voltage on-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. If correct check "UFRO" setting. Refer to subsection 4.7.1.1.</li> </ol>  |
| Excessive voltage/speed dip on load switching   | <ol style="list-style-type: none"> <li>1. Check governor response. Refer to generating set manual. Check "DIP" setting. Refer to subsection 4.7.1.4.</li> </ol>  |
| Sluggish recovery on load switching             | <ol style="list-style-type: none"> <li>1. Check governor response. Refer to generating set manual.</li> </ol>  |

**7.4.6 MX321 AVR - FAULT FINDING**

|   |  |
|---|--|
| No voltage build-up when starting set           | <ol style="list-style-type: none"> <li>1. Check link K1-K2 on auxiliary terminals. Follow Separate Excitation Test Procedure to check machine and AVR. Refer to subsection 7.5.</li> </ol>                 |
| Voltage very slow to build up                   | <ol style="list-style-type: none"> <li>1. Check setting of ramp potentiometer. Refer to 4.7.1.5.</li> </ol>  |
| Loss of voltage when set running                | <ol style="list-style-type: none"> <li>1. First stop and re-start set. If no voltage or voltage collapses after short time, follow Separate Excitation Test Procedure. Refer to subsection 7.5.</li> </ol> |
| Generator voltage high followed by collapse     | <ol style="list-style-type: none"> <li>1. Check sensing leads to AVR.</li> <li>2. Refer to Separate Excitation Test Procedure. Refer to subsection 7.5.</li> </ol>   |
| Voltage unstable either on no-load or with load | <ol style="list-style-type: none"> <li>1. Check speed stability.</li> <li>2. Check "STAB" setting. Refer to Load Testing section for procedure. Refer to subsection 4.6.</li> </ol>                        |
| Low voltage on-load                             | <ol style="list-style-type: none"> <li>1. Check speed.</li> <li>2. If correct check "UFRO" setting. Refer to subsection 4.7.1.1.</li> </ol>  |
| Excessive voltage/speed dip on load switching   | <ol style="list-style-type: none"> <li>1. Check governor responses. Refer to generating set manual. Check "DIP" setting. Refer to subsection 4.7.1.4.</li> </ol>   |
| Sluggish recovery on load switching             | <ol style="list-style-type: none"> <li>1. Check governor response. Refer to generating set manual. Check "DWELL" setting. Refer to Load Testing section 4.7.1.4.</li> </ol>                                |

### 7.4.7 RESIDUAL VOLTAGE CHECK

This procedure is applicable to generators with either SX460 or SX440 or SX421 AVR.

With the generator set stationary remove AVR access cover and leads X and XX from the AVR.

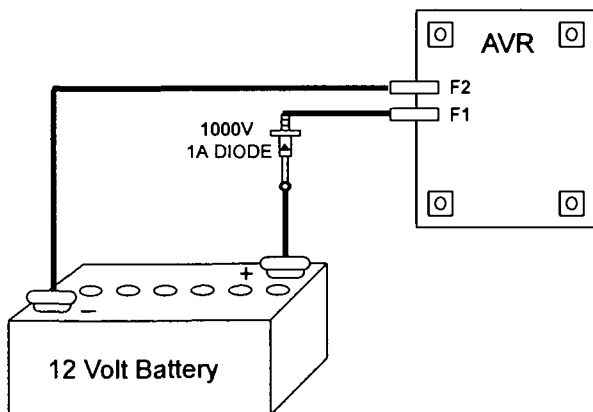
Start the set and measure voltage across AVR terminals 7-8 on SX460 AVR or P2-P3 on SX440 or SX421 AVR.

Stop the set, and replace leads X and XX on the AVR terminals. If the measured voltage was above 5V the generator should operate normally.

If the measured voltage was under 5V follow the procedure below.

Using a 12 volt d. c. battery as a supply clip leads from battery negative to AVR terminal XX, and from battery positive through a diode to AVR terminal X. See Fig. 10.

**Important ! A diode must be used as shown below to ensure the AVR is not damaged.**



**Fig. 11**

**Important ! If the generating set battery is used for field flashing the generator main stator neutral must be disconnected from earth.**

Restart the set and note output voltage from main stator, which should be approximately nominal voltage, or voltage at AVR terminals 7 and 8 on SX460, P2-P3 on SX440 or SX421 which should be between 170 and 250 volts.

Stop the set and unclip battery supply from terminals X and XX. Restart the set. The generator should now operate normally. If no voltage build-up is obtained it can be assumed a fault exists in either the generator or the AVR circuits. Follow the SEPARATE EXCITATION TEST PROCEDURE to check generator windings, rotating diodes and AVR. Refer to subsection 7.5.

### 7.5 SEPARATE EXCITATION TEST PROCEDURE

The generator windings, diode assembly and AVR can be checked using the appropriate following section.

#### 7.5.1 GENERATOR WINDINGS, ROTATING DIODES and PERMANENT MAGNET GENERATOR (PMG)

#### 7.5.2 EXCITATION CONTROL TEST.

### 7.5.1 GENERATOR WINDINGS, ROTATING DIODES and PERMANENT MAGNET GENERATOR (PMG)

**Important ! The resistances quoted apply to a standard winding. For generators having windings or voltages other than those specified refer to factory for details. Ensure all disconnected leads are isolated and free from earth.**

**Important ! Incorrect speed setting will give proportional error in voltage output.**

#### CHECKING PMG

Start the set and run at rated speed.

Measure the voltages at the AVR terminals P2, P3 and P4. These should be balanced and within the following ranges:-

50Hz generators - 170-180 volts

60Hz generators - 200-216 volts

Should the voltages be unbalanced stop the set, remove the PMG sheet metal cover from the non drive end bracket and disconnect the multipin plug in the PMG output leads. Check leads P2, P3, P4 for continuity. Check the PMG stator resistances between output leads. These should be balanced and within  $\pm 10\%$  of 2.3 ohms. If resistances are unbalanced and/or incorrect the PMG stator must be replaced. If the voltages are balanced but low and the PMG stator winding resistances are correct - the PMG rotor must be replaced.

#### CHECKING GENERATOR WINDINGS AND ROTATING DIODES

This procedure is carried out with leads X and XX disconnected at the AVR or transformer control rectifier bridge and using a 12 volt d.c. supply to leads X and XX.

Start the set and run at rated speed.

Measure the voltages at the main output terminals U, V and W. If voltages are balanced and within  $\pm 10\%$  of the generator nominal voltage, refer to 7.5.1.1.

Check voltages at AVR terminals 6, 7 and 8. These should be balanced and between 170-250 volts.

If voltages at main terminals are balanced but voltage at 6, 7 and 8 are unbalanced, check continuity of leads 6, 7 and 8. Where an isolating transformer is fitted (MX321 AVR) check transformer windings. If faulty the transformer unit must be replaced.

If voltages are unbalanced, refer to 7.5.1.2.

#### 7.5.1.1 BALANCED MAIN TERMINAL VOLTAGES

If all voltages are balanced within 1% at the main terminals, it can be assumed that all exciter windings, main windings and main rotating diodes are in good order, and the fault is in the AVR or transformer control. Refer to subsection 7.5.2 for test procedure.

If voltages are balanced but low, there is a fault in the main excitation windings or rotating diode assembly. Proceed as follows to identify:-

## Rectifier Diodes

The diodes on the main rectifier assembly can be checked with a multimeter. The flexible leads connected to each diode should be disconnected at the terminal end, and the forward and reverse resistance checked. A healthy diode will indicate a very high resistance (infinity) in the reverse direction, and a low resistance in the forward direction. A faulty diode will give a full deflection reading in both directions with the test meter on the 10,000 ohms scale, or an infinity reading in both directions.

On an electronic digital meter a healthy diode will give a low reading in one direction, and a high reading in the other.

## Replacement of Faulty Diodes

The rectifier assembly is split into two plates, the positive and negative, and the main rotor is connected across these plates. Each plate carries 3 diodes, the negative plate carrying negative biased diodes and the positive plate carrying positive biased diodes. Care must be taken to ensure that the correct polarity diodes are fitted to each respective plate. When fitting the diodes to the plates they must be tight enough to ensure a good mechanical and electrical contact, but should not be overtightened. The recommended torque tightening is 4.06 - 4.74Nm (36-42lb in).

## Surge Suppressor

The surge suppressor is a metal-oxide varistor connected across the two rectifier plates to prevent high transient reverse voltages in the field winding from damaging the diodes. This device is not polarised and will show a virtually infinite reading in both directions with an ordinary resistance meter. If defective this will be visible by inspection, since it will normally fail to short circuit and show signs of disintegration. Replace if faulty.

## Main Excitation Windings

If after establishing and correcting any fault on the rectifier assembly the output is still low when separately excited, then the main rotor, exciter stator and exciter rotor winding resistances should be checked (see Resistance Charts), as the fault must be in one of these windings. The exciter stator resistance is measured across leads X and XX. The exciter rotor is connected to six studs which also carry the diode lead terminals. The main rotor winding is connected across the two rectifier plates. The respective leads must be disconnected before taking the readings.

Resistance values should be within +/-10% of the values given in the table below:-

| Frame Size | Main Rotor | Exciter Stator |         |          | Exciter Rotor |
|------------|------------|----------------|---------|----------|---------------|
|            |            | Type 1         | Type 2* | Type 3** |               |
| UC22C      | 0.59       | 21             | 28      | 138      | 0.142         |
| UC22D      | 0.64       | 21             | 28      | 138      | 0.142         |
| UC22E      | 0.69       | 20             | 30      | 155      | 0.156         |
| UC22F      | 0.83       | 20             | 30      | 155      | 0.156         |
| UC22G      | 0.94       | 20             | 30      | 155      | 0.156         |
| UC27C      | 1.12       | 20             | -       | -        | 0.156         |
| UC27D      | 1.26       | 20             | -       | -        | 0.156         |
| UC27E      | 1.34       | 20             | -       | -        | 0.182         |
| UC27F      | 1.52       | 20             | -       | -        | 0.182         |
| UC27G      | 1.69       | 20             | -       | -        | 0.182         |
| UC27H      | 1.82       | 20             | -       | -        | 0.182         |
| UCD27J     | 2.08       | 20             | -       | -        | 0.182         |
| UCD27K     | 2.08       | 20             | -       | -        | 0.182         |

\* Used with 1 phase transformer controlled 3 phase or 1 phase generators.

\*\* Used with 3 phase transformer controlled 3 phase generators.

## 7.5.1.2 UNBALANCED MAIN TERMINAL VOLTAGES

If voltages are unbalanced, this indicates a fault on the main stator winding or main cables to the circuit breaker. NOTE: Faults on the stator winding or cables may also cause noticeable load increase on the engine when excitation is applied. Disconnect the main cables and separate the winding leads U1-U2, U5-U6, V1-V2, V5-V6, W1-W2, W5-W6 to isolate each winding section. (U1-L1, U2-L4 on single phase generators).

Measure each section resistance - values should be balanced and within +/-10% of the value given below:-

| AVR CONTROLLED GENERATORS |                     |            |            |            |
|---------------------------|---------------------|------------|------------|------------|
| Frame Size                | SECTION RESISTANCES |            |            |            |
|                           | Winding 311         | Winding 17 | Winding 05 | Winding 06 |
| UC22C                     | 0.09                | 0.14       | 0.045      | 0.03       |
| UC22D                     | 0.065               | 0.1        | 0.033      | 0.025      |
| UC22E                     | 0.05                | 0.075      | 0.028      | 0.02       |
| UC22F                     | 0.033               | 0.051      | 0.018      | 0.012      |
| UC22G                     | 0.028               | 0.043      | 0.014      | 0.01       |
| UC27C                     | 0.03                | 0.044      | 0.016      | 0.011      |
| UC27D                     | 0.019               | 0.026      | 0.01       | 0.007      |
| UC27E                     | 0.016               | 0.025      | 0.009      | 0.008      |
| UC27F                     | 0.012               | 0.019      | 0.007      | 0.005      |
| UC27G                     | 0.01                | 0.013      | 0.006      | 0.004      |
| UC27H                     | 0.008               | 0.014      | 0.004      | 0.004      |
| UCD27J                    | 0.006               | 0.009      | -          | -          |
| UCD27K                    | 0.006               | 0.009      | -          | -          |

| TRANSFORMER CONTROLLED GENERATORS |                                       |       |       |       |       |
|-----------------------------------|---------------------------------------|-------|-------|-------|-------|
| Frame Size                        | SECTION RESISTANCES, 3 PHASE WINDINGS |       |       |       |       |
|                                   | 380V                                  | 400V  | 415V  | 416V  | 460V  |
|                                   | 50Hz                                  | 50Hz  | 50Hz  | 60Hz  | 60Hz  |
| UC22C                             | 0.059                                 | 0.078 | 0.082 | 0.055 | 0.059 |
| UC22D                             | 0.054                                 | 0.056 | 0.057 | 0.049 | 0.054 |
| UC22E                             | 0.041                                 | 0.05  | 0.053 | 0.038 | 0.041 |
| UC22F                             | 0.031                                 | 0.032 | 0.033 | 0.025 | 0.031 |
| UC22G                             | 0.022                                 | 0.026 | 0.028 | 0.021 | 0.022 |

Measure insulation resistance between sections and each section to earth.

Unbalanced or incorrect winding resistances and/or low insulation resistances to earth indicate rewinding of the stator will be necessary. Refer to removal and replacement of component assemblies subsection 7.5.3.

## 7.5.2 EXCITATION CONTROL TEST

### 7.5.2.1 AVR FUNCTION TEST

All types of AVR's can be tested with this procedure:

1. Remove exciter field leads X & XX (F1 & F2) from the AVR terminals X & XX (F1 & F2).
2. Connect a 60W 240V household lamp to AVR terminals X & XX (F1 & F2).
3. Set the AVR VOLTS control potentiometer fully clockwise.
4. Connect a 12V, 1.0A DC supply to the exciter field leads X & XX (F1 & F2) with X (F1) to the positive.

5. Start the generating set and run at rated speed.
6. Check that the generator output voltage is within +/-10% of rated voltage.

Voltages at AVR terminals 7-8 on SX460 AVR or P2-P3 on SX440 or SX421 AVR should be between 170 and 250 volts. If the generator output voltage is correct but the voltage on 7-8 (or P2-P3) is low, check auxiliary leads and connections to main terminals.

Voltages at P2, P3, P4 terminals on MX341 and MX321 should be as given in 7.5.1.

The lamp connected across X-XX should glow. In the case of the SX460, SX440 and SX421 AVRs the lamp should glow continuously. In the case of the MX341 and MX321 AVRs the lamp should glow for approximately 8 secs. and then turn off. Failure to turn off indicates faulty protection circuit and the AVR should be replaced. Turning the "VOLTS" control potentiometer fully anti-clockwise should turn off the lamp with all AVR types.

Should the lamp fail to light the AVR is faulty and should be replaced.

**Important !** After this test turn VOLTS control potentiometer fully anti-clockwise.

### 7.5.2.2 TRANSFORMER CONTROL

The transformer rectifier unit can only be checked by continuity, resistance checks and insulation resistance measurement.

#### Two phase transformer

Separate primary leads T1-T2-T3-T4 and secondary leads 10-11. Examine windings for damage. Measure resistances across T1-T3 and T2-T4. These will be a low value but should be balanced. Check that there is resistance in the order of 8 ohms between leads 10 and 11. Check insulation resistance of each winding section to earth and to other winding sections.

Low insulation resistance, unbalanced primary resistance, open or short circuited winding sections, indicates the transformer unit should be replaced.

#### Three phase transformer

Separate primary leads T1-T2-T3 and secondary leads 6-7-8 and 10-11-12.

Examine windings for damage. Measure resistances across T1-T2, T2-T3, T3-T1. These will be low but should be balanced. Check that resistances are balanced across 6-10, 7-11 and 8-12 and in the order of 18 ohms.

Check insulation resistance of each winding section to earth and to other winding sections.

Low insulation resistance, unbalanced primary or secondary winding resistances, open or short circuited winding sections indicates the transformer unit should be replaced.

#### Rectifier units - Three phase and single phase

With the leads 10-11-12-X and XX removed from the rectifier unit (lead 12 is not fitted on single phase transformer rectifier units), check forward and reverse resistances between terminals 10-X, 11-X, 12-X, 10-XX, 11-XX and 12-XX with a multimeter.

A low forward resistance and high reverse resistance should be read between each pair of terminals. If this is not the case the unit is faulty and should be replaced.

## 7.5.3 REMOVAL AND REPLACEMENT OF COMPONENT ASSEMBLIES

METRIC THREADS ARE USED THROUGHOUT

**Caution !** When lifting single bearing generators, care is needed to ensure the generator frame is kept in the horizontal plane. The rotor is free to move in the frame and can slide out if not correctly lifted. Incorrect lifting can cause serious personal injury.

### 7.5.3.1 REMOVAL OF PERMANENT MAGNET GENERATOR (PMG)

1. Remove 4 screws holding the sheet metal cylindrical cover at the non-drive end and remove the cover.
2. Disconnect the in line connector from the PMG stator (3 wires go to this connector). It may be necessary to cut off the nylon cable tie first.
3. Remove the 4 threaded pillars and clamps holding the PMG stator onto the end bracket.
4. Tap the stator out of the 4 spigots and withdraw. The highly magnetic rotor will attract the stator. Take care to avoid contact which may damage the windings.
5. Remove the bolt in the centre from the rotor shaft and pull off the rotor. It may be necessary to gently tap the rotor away. Take care to tap gently and evenly - the rotor has ceramic magnets which are easily broken by shock.

**Important !** The rotor assembly must not be dismantled.

Replacement is a reversal of the above procedure.

### 7.5.3.2 REMOVAL OF BEARINGS

**Important !** Position the main rotor so that a full pole face of the main rotor core is at the bottom of the stator bore.

NOTE: Removal of the bearings may be effected either after the rotor assembly has been removed OR more simply by removal of endbracket(s). Refer to 7.5.3.3. and 7.5.3.4.

The bearings are pre-packed with grease and sealed for life.

The bearing(s) are a press fit and can be removed from the shaft with 3 leg or 2 leg manual or hydraulic bearing pullers.

**SINGLE BEARING ONLY:** Before trying to pull off the bearing remove the small circlip retaining it.

When fitting new bearings use a bearing heater to expand the bearing before fitting to the shaft. Tap the bearing into place ensuring that it contacts the shoulder on the shaft.

Refit the retaining circlip on single bearing generators.

### 7.5.3.3 REMOVAL OF ENDBRACKET AND EXCITER STATOR

1. Remove exciter leads X+, XX- at the AVR.
2. Slacken 4 bolts (2 each side) situated on horizontal centre line holding the terminal box.
3. Remove 2 bolts holding lifting lug, at the non-drive end, and remove lug.

4. Remove sheet metal cylindrical cover (4 screws) over PMG (if fitted)  
or  
Remove shallow sheet metal cover (4 screws) at the non-drive end.
5. Ease up the terminal box and support clear of the non-drive endbracket.
6. Remove 6 bolts holding the non-drive endbracket to the stator bar assembly. The endbracket is now ready for removal.
7. Replace the lifting lug onto the endbracket and sling the endbracket on a hoist to facilitate lifting.
8. Tap the endbracket around its perimeter to release from the generator. The endbracket and exciter stator will come away as a single assembly.
9. Remove the 4 screws holding the exciter stator to the endbracket and gently tap the exciter stator to release it. Replacement is a reversal of the above procedure.

#### 7.5.3.4 REMOVAL OF THE ROTOR ASSEMBLY

Remove the permanent magnet generator. Refer to 7.5.3.1 or

Remove the four screws holding the sheet metal cover at the non drive end and remove cover.

**Caution !** With the PMG rotor removed single bearing generator rotors are free to move in the frame. Ensure frame is kept in the horizontal plane when lifting.

#### TWO BEARING GENERATORS

1. Remove 2 screws holding the sheet metal cover around the adaptor at the drive end and remove the cover.
2. Remove the bolts holding the adaptor to the endbracket at the drive end.
3. Tap off the adaptor. It may be preferred to sling the adaptor first depending on its size and weight.
4. Remove the screens and louvres (if fitted) at each side on the drive end.

Now ensure that the rotor is positioned with a full pole face at the bottom centre line. This is to avoid damage to the bearing exciter, or rotor winding, by limiting the possible rotor downward movement to the air gap length.

5. Remove 6 bolts holding drive endbracket onto adaptor ring DE. The boltheads face towards the non-drive end. The top bolt passes through the centre of the lifting lug.
6. Tap the drive endbracket away from the adaptor ring DE and withdraw the endbracket.
7. Ensure the rotor is supported at the drive end on a sling.
8. Tap the rotor from the non-drive end to push the bearing clear of the endbracket and its position within an 'O' ring.
9. Continue to push the rotor out of the stator bore, gradually working the sling along the rotor as it is withdrawn, to ensure that it is fully supported all the time.

#### SINGLE BEARING GENERATORS

1. Remove the screws, screens and louvres (if fitted) at each side on drive end adaptor.

##### 2. UCI224, UCI274, UCM224, UCM274, UCD274 Only

Remove 6 bolts holding the adaptor at the drive end. It may be preferred to sling the adaptor on a hoist. The bolt heads face towards the non-drive end. The top bolt passes through the centre of the lifting lug.

##### 2a. UCD224 Only

Remove 6 bolts holding the adaptor at the drive end. It may be preferred to sling the adaptor on a hoist.

##### 3. UCI224, UCI274, UCM224, UCM274, UCD274 Only

Tap the adaptor away from stator bar adaptor ring.

##### 3a. UCD224 Only

Tap the adaptor away from stator bar assembly.

#### ALL SINGLE BEARING GENERATORS

4. Ensure the rotor is supported at drive end on a sling.
5. Tap the rotor from the non-drive end to push the bearing clear of the endbracket and its position within an 'O' ring.
6. Continue to push the rotor out of the stator bore, gradually working the sling along the rotor as it is withdrawn, to ensure that it is fully supported at all times.

Replacement of rotor assemblies is a reversal of the procedures above.

Before commencing re-assembly, components should be checked for damage and bearing(s) examined for loss of grease.

Fitting of new bearing(s) is recommended during major overhaul.

Before replacement of a single bearing rotor assembly, check that the drive discs are not damaged, cracked or showing other signs of fatigue. Also check that the holes in the discs for drive fixing screws are not elongated.

Damaged or worn components must be replaced.

**Caution !** When major components have been replaced, ensure that all covers and guards are securely fitted, before the generator is put into service.

#### 7.6 RETURNING TO SERVICE

After rectification of any faults found, remove all test connections and reconnect all control system leads.

Restart the set and adjust VOLTS control potentiometer on AVR controlled generators by slowly turning clockwise until rated voltage is obtained.

Refit all terminal box covers/access covers and reconnect heater supply.

**Caution !** Failure to refit all guards, access covers and terminal box covers can result in personal injury of death.

## **SECTION 8**

### **SPARES AND AFTER SALES SERVICE**

#### **8.1 RECOMMENDED SPARES**

Service parts are conveniently packaged for easy identification. Genuine parts may be recognised by the Nupart name.

We recommend the following for Service and Maintenance. In critical applications a set of these service spares should be held with the generator.

##### **AVR Controlled Generators**

|    |  |      |           |
|----|--|------|-----------|
| 1. | Diode Set (6 diodes with surge suppressor) | RSK  | 2001      |
| 2. | AVR SX440                                  | E000 | 24030     |
|    | AVR SX460                                  | E000 | 24602     |
|    | AVR SX421                                  | E000 | 24210     |
|    | AVR MX321                                  | E000 | 23212     |
|    | AVR MX341                                  | E000 | 23410     |
| 3. | Non drive end Bearing                      | UC22 | 051 01032 |
|    |  | UC27 | 051 01049 |
| 4. | Drive end Bearing                          | UC22 | 051 01044 |
|    |  | UC27 | 051 01050 |

##### **Transformer Controlled Generators (UC22 Only)**

|    |  |      |           |
|----|--|------|-----------|
| 1. | Diode Set (6 diodes with surge suppressor) | RSK  | 2001      |
| 2. | Diode Assembly                             | E000 | 22006     |
| 3. | Non drive end Bearing                      | UC22 | 051 01032 |
| 4. | Drive end Bearing                          | UC22 | 051 01044 |

When ordering parts the machine serial number or machine identity number and type should be quoted, together with the part description. For location of these numbers see paragraph 1.3.

Orders and enquiries for parts should be addressed to:

Newage International Limited  
Nupart Department  
PO Box 17, Barnack Road  
STAMFORD  
Lincolnshire  
PE9 2NB  
ENGLAND

Telephone: 44 (0) 1780 484000  
Fax: 44 (0) 1780 766074

Or any of our subsidiary companies listed on the back cover.

#### **8.2 AFTER SALES SERVICE**

A full technical advice and on-site service facility is available from our Service Department at Stamford or through our Subsidiary Companies. A repair facility is also available at our Stamford Works.

## PARTS LIST

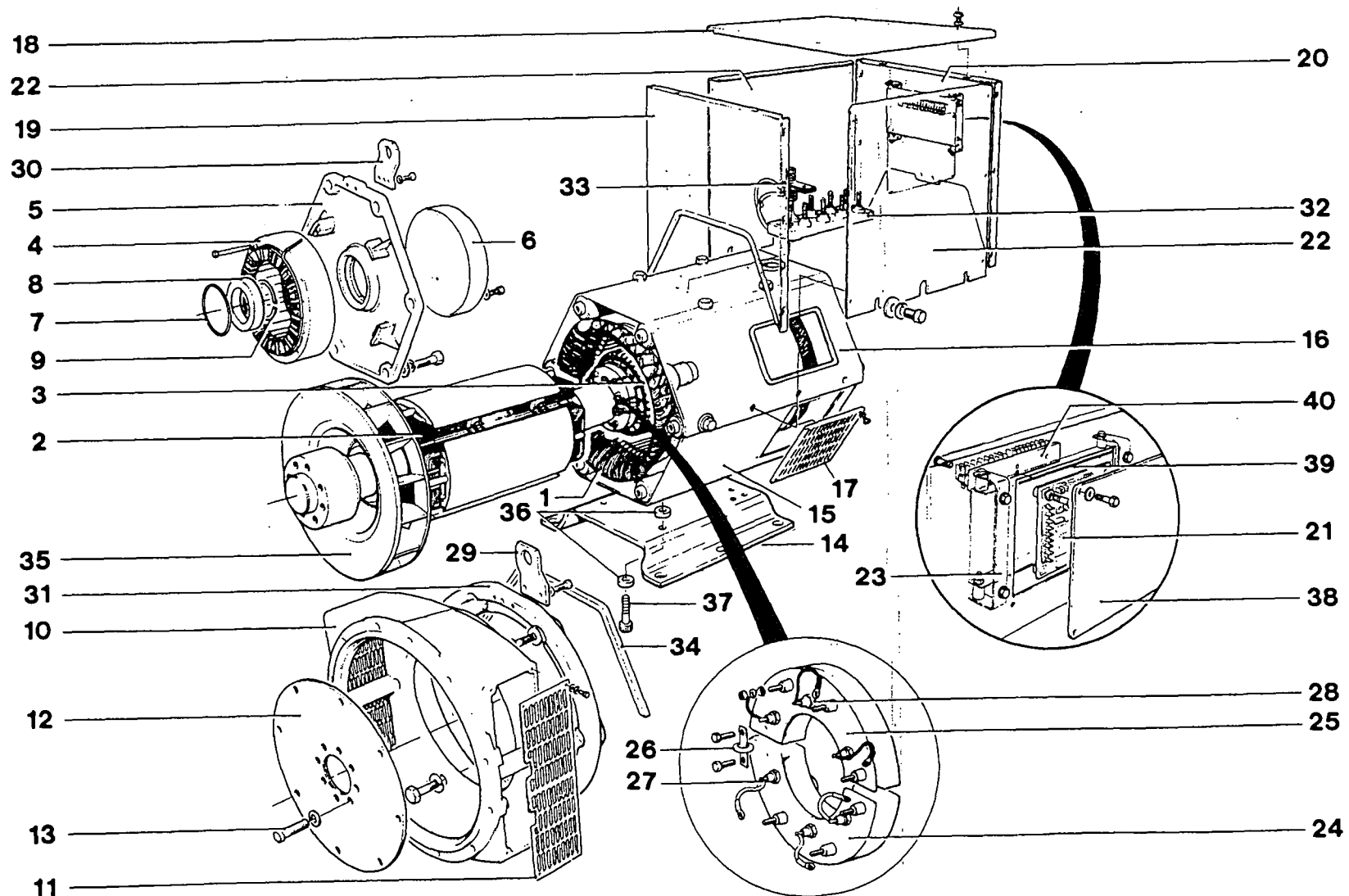
### TYPICAL SINGLE BEARING GENERATOR

| Plate Ref. | Description                       | Plate Ref. | Description                          |
|------------|-----------------------------------|------------|--------------------------------------|
| 1          | Stator                            | 25         | Main Rectifier Assembly - Reverse    |
| 2          | Rotor                             | 26         | Varistor                             |
| 3          | Exciter Rotor                     | 27         | Diode - Forward Polarity             |
| 4          | Exciter Stator                    | 28         | Diode - Reverse Polarity             |
| 5          | N.D.E. Bracket                    | 29         | Lifting Lug - D.E.                   |
| 6          | Cover N.D.E.                      | 30         | Lifting Lug - N.D.E.                 |
| 7          | Bearing 'O' Ring N.D.E.           | 31         | Frame to Endbracket Adaptor Ring     |
| 8          | Bearing N.D.E.                    | 32         | Main Terminal Panel                  |
| 9          | Bearing Circlip N.D.E.            | 33         | Terminal Link                        |
| 10         | D.E. Bracket/Engine Adaptor       | 34         | Edging Strip                         |
| 11         | D.E. Screen                       | 35         | Fan                                  |
| 12         | Coupling Disc                     | 36         | Foot Mounting Spacer                 |
| 13         | Coupling Bolt                     | 37         | Cap Screw                            |
| 14         | Foot                              | 38         | AVR Access Cover                     |
| 15         | Frame Cover Bottom                | 39         | AVR Anti-Vibration Mounting Assembly |
| 16         | Frame Cover Top                   | 40         | Auxiliary Terminal Assembly          |
| 17         | Air Inlet Cover                   |            |                                      |
| 18         | Terminal Box Lid                  |            |                                      |
| 19         | Endpanel D.E.                     |            |                                      |
| 20         | Endpanel N.D.E.                   |            |                                      |
| 21         | AVR                               |            |                                      |
| 22         | Side Panel                        |            |                                      |
| 23         | AVR Mounting Bracket              |            |                                      |
| 24         | Main Rectifier Assembly - Forward |            |                                      |

|        |                             |
|--------|-----------------------------|
| N.D.E. | Non Drive End               |
| D.E.   | Drive End                   |
| PMG    | Permanent Magnet Generator  |
| AVR    | Automatic Voltage Regulator |



**Fig. 11.**  
**TYPICAL SINGLE BEARING GENERATOR**



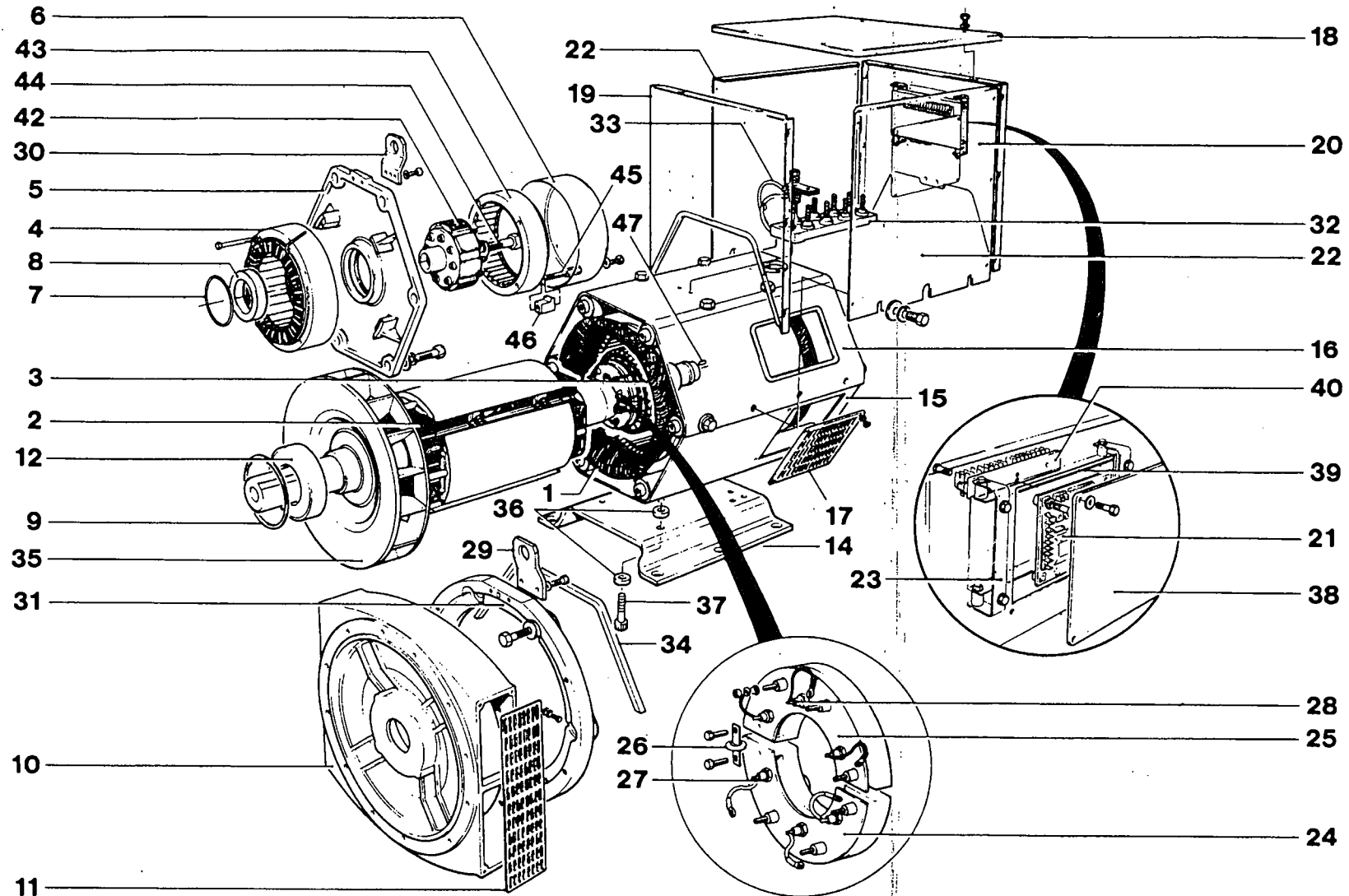
## PARTS LIST

### TYPICAL TWO BEARING GENERATOR

| Plate Ref. | Description                       | Plate Ref. | Description                       |
|------------|-----------------------------------|------------|-----------------------------------|
| 1          | Stator                            | 25         | Main Rectifier Assembly - Reverse |
| 2          | Rotor                             | 26         | Varistor                          |
| 3          | Exciter Rotor                     | 27         | Diode - Forward Polarity          |
| 4          | Exciter Stator                    | 28         | Diode - Reverse Polarity          |
| 5          | N.D.E. Bracket                    | 29         | Lifting Lug - D.E.                |
| 6          | Cover N.D.E.                      | 30         | Lifting Lug - N.D.E.              |
| 7          | Bearing 'O' Ring N.D.E.           | 31         | Frame to Endbracket Adaptor Ring  |
| 8          | Bearing N.D.E.                    | 32         | Main Terminal Panel               |
| 9          | Bearing Wave Washer D.E.          | 33         | Terminal Link                     |
| 10         | D.E. Bracket                      | 34         | Edging Strip                      |
| 11         | D.E. Screen                       | 35         | Fan                               |
| 12         | Bearing D.E.                      | 36         | Foot Mounting Spacer              |
| 14         | Foot                              | 37         | Cap Screw                         |
| 15         | Frame Cover Bottom                | 38         | AVR Access Cover                  |
| 16         | Frame Cover Top                   | 39         | AVR Anti-Vibration Mount          |
| 17         | Air Inlet Cover                   | 40         | Auxiliary Terminal Assembly       |
| 18         | Terminal Box Lid                  | 42         | PMG Exciter Rotor                 |
| 19         | Endpanel D.E.                     | 43         | PMG Exciter Stator                |
| 20         | Endpanel N.D.E.                   | 44         | PMG Bolt                          |
| 21         | AVR                               | 45         | PMG Pillar                        |
| 22         | Side Panel                        | 46         | PMG Clamp                         |
| 23         | AVR Mounting Bracket              | 47         | PMG Dowel                         |
| 24         | Main Rectifier Assembly - Forward |            |                                   |

|        |                             |
|--------|-----------------------------|
| N.D.E. | Non Drive End               |
| D.E.   | Drive End                   |
| PMG    | Permanent Magnet Generator  |
| AVR    | Automatic Voltage Regulator |

**Fig. 12.**  
**TYPICAL TWO BEARING GENERATOR**



35

## PARTS LIST

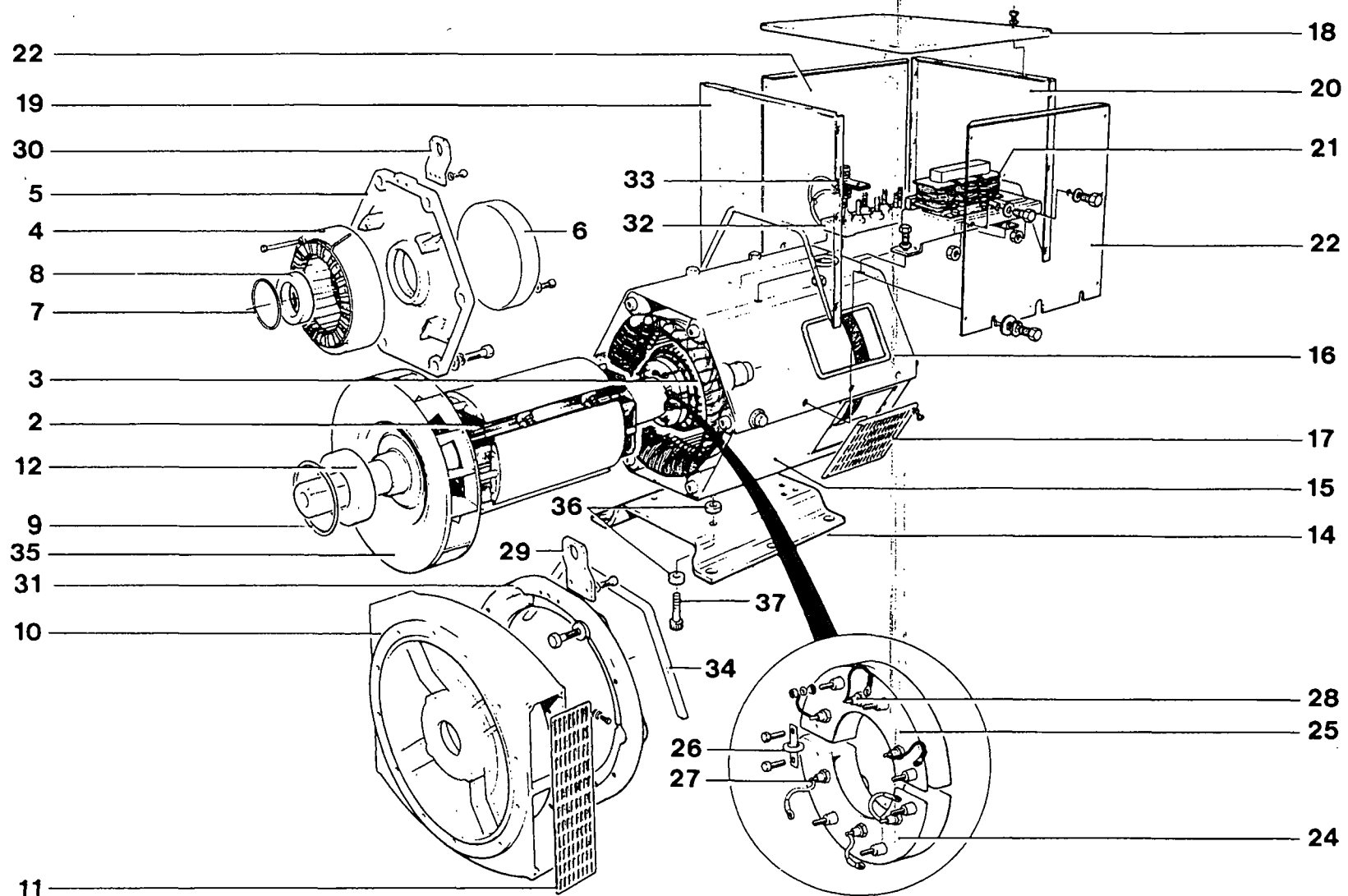
### TYPICAL TWO BEARING (SERIES 5) GENERATOR

| Plate Ref. | Description                       | Plate Ref. | Description                       |
|------------|-----------------------------------|------------|-----------------------------------|
| 1          | Stator                            | 25         | Main Rectifier Assembly - Reverse |
| 2          | Rotor                             | 26         | Varistor                          |
| 3          | Exciter Rotor                     | 27         | Diode - Forward Polarity          |
| 4          | Exciter Stator                    | 28         | Diode - Reverse Polarity          |
| 5          | N.D.E. Bracket                    | 29         | Lifting Lug - D.E.                |
| 6          | Cover N.D.E.                      | 30         | Lifting Lug - N.D.E.              |
| 7          | Bearing 'O' Ring N.D.E.           | 31         | Frame to Endbracket Adaptor Ring  |
| 8          | Bearing N.D.E.                    | 32         | Main Terminal Panel               |
| 9          | Bearing Wave Washer D.E.          | 33         | Terminal Link                     |
| 10         | D.E. Bracket                      | 34         | Edging Strip                      |
| 11         | D.E. Screen                       | 35         | Fan                               |
| 12         | Bearing D.E.                      | 36         | Foot Mounting Spacer              |
| 13         |                                   | 37         | Cap Screw                         |
| 14         | Foot                              |            |                                   |
| 15         | Frame Cover Bottom                |            |                                   |
| 16         | Frame Cover Top                   |            |                                   |
| 17         | Air Inlet Cover                   |            |                                   |
| 18         | Terminal Box Lid                  |            |                                   |
| 19         | Endpanel D.E.                     |            |                                   |
| 20         | Endpanel N.D.E.                   |            |                                   |
| 21         | Series 5 Control Gear             |            |                                   |
| 22         | Side Panel                        |            |                                   |
| 23         |                                   |            |                                   |
| 24         | Main Rectifier Assembly - Forward |            |                                   |

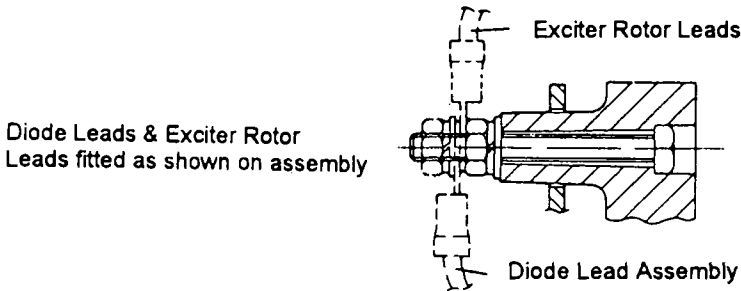
N.D.E.  
D.E.

Non Drive End  
Drive End

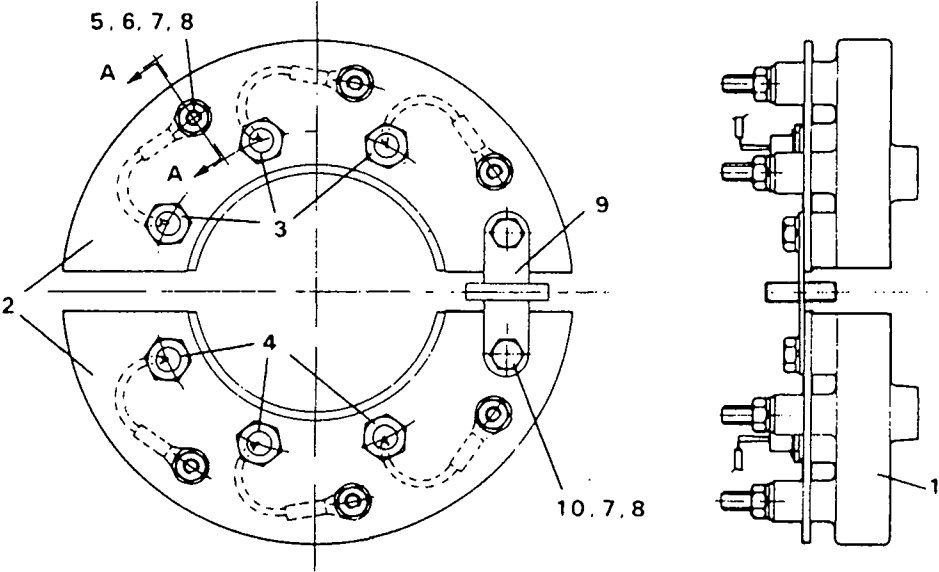
**Fig. 13.**  
**TYPICAL TWO BEARING (SERIES 5) GENERATOR**



**Fig. 14.**  
**ROTATING RECTIFIER ASSEMBLY**



Scrap Section A-A



| Plate Ref. | Description  | Qty |
|------------|--------------|-----|
| 1          | Hub          | 1   |
| 2          | Fin          | 2   |
| 3          | Diode (fwd)  | 3   |
| 4          | Diode (rev)  | 3   |
| 5          | Hx. Screw    | 6   |
| 6          | Hx. Nut      | 6   |
| 7          | Pl. Washer   | 8   |
| 8          | SC. L/Washer | 8   |
| 9          | Varistor     | 1   |
| 10         | Hx. Screw    | 2   |

**NOTES:**  
Fitting of Diodes.

1. Underside of diodes to be smeared with Midland Silicone 'Heat Sink' compound type MS2623. This compound **must not** be applied to the diode threads.
2. Diodes to be tightened to a torque of 2.03 - 2.37 Nm.
3. For Nupart rectifier service kit see page 28.

This manual is available in the following languages on request:  
English, French, German, Italian and Spanish.

Denne manual er til rådighed på følgende sprog: engelsk, fransk, tysk, italiensk og spansk.

Denne håndboken er tilgjengelig på de følgende språkene: engelsk, fransk, tysk, italiensk og spansk.

Sur simple demande, ce manuel vous sera fourni dans l'une des langues suivantes: anglais, français, allemand, italien, espagnol.

Dieses Handbuch ist auf Anfrage in den folgenden Sprachen erhältlich: Englisch, Französisch, Deutsch, Italienisch, Spanisch.

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Tämä käsikirja on saatavissa pyynnöstä seuraavilla kielillä: Englanti, ranska, saksa, italia, espanja.

Il presente manuale è disponibile, su richiesta, nelle seguenti lingue: inglese, francese, tedesco, italiano e spagnolo.

Este manual también puede solicitarse en los siguientes idiomas: inglés, francés, alemán, italiano e español.

Αυτό το εγχειρίδιο οδηγιών χρήσεως διατίθεται στις ακόλουθες γλώσσες κατόπιν αιτήσεως: Αγγλικά, Γαλλικά, Γερμανικά, Ιταλικά, Ισπανικά.



## A.C. GENERATOR WARRANTY

### WARRANTY PERIOD

#### A.C. Generators

In respect of a.c. generators the Warranty Period is eighteen months from the date when the goods have been notified as ready for despatch by N.I. or twelve months from the date of first commissioning (whichever is the shorter period).

### DEFECTS AFTER DELIVERY

We will make good by repair or, at our option, by the supply of a replacement, any fault which under proper use appears in the goods within the period specified on Clause 12, and is found on examination by us to be solely due to defective material and workmanship; provided that the defective part is promptly returned, carriage paid, with all identification numbers and marks intact, or our works or, if appropriate to the Dealer who supplied the goods.

Any part repaired or replaced, under warranty, will be returned by N.I. free of charge (via sea freight if outside the UK).

We shall not be liable for any expenses which may be incurred in removing or replacing any part sent to us for inspection or in fitting any replacement supplied by us. We shall be under no liability for defects in any goods which have not been properly installed in accordance with N.I. recommended installation practices as detailed in the publications 'N.I. Installation, Service and Maintenance Manual' and 'N.I. Application Guidelines', or which have been improperly stored or which have been repaired, adjusted or altered by any person except ourselves or our authorised agents, or in any second-hand goods, proprietary articles or goods not of our own manufacture although supplied by us, such articles and goods being covered by the warranty (if any) given by the separate manufacturers.

Any claim under this clause must contain fully particulars of the alleged defect, the description of the goods, the date of purchase, and the name and address of the Vendor, the Serial Number (as shown on the manufacturers identification plate) or for Spares the order reference under which the goods were supplied.

Our judgement in all cases of claims shall be final and conclusive and the claimant shall accept our decision on all questions as to defects and the exchange of a part or parts.

Our liability shall be fully discharged by either repair or replacement as above, and in any event shall not exceed the current list price of the defective goods.

Our liability under this clause shall be in lieu of any warranty or condition implied by law as to the quality or fitness for any particular purpose of the goods, and save as expressly provided in this clause we shall not be under any liability, whether in contract, tort or otherwise, in respect of defects in goods delivered or for any injury, damages or loss resulting from such defects or from any work undone in connection therewith.

MACHINE SERIAL NUMBER

# NEWAGE INTERNATIONAL LIMITED

## REGISTERED OFFICE AND ADDRESS:

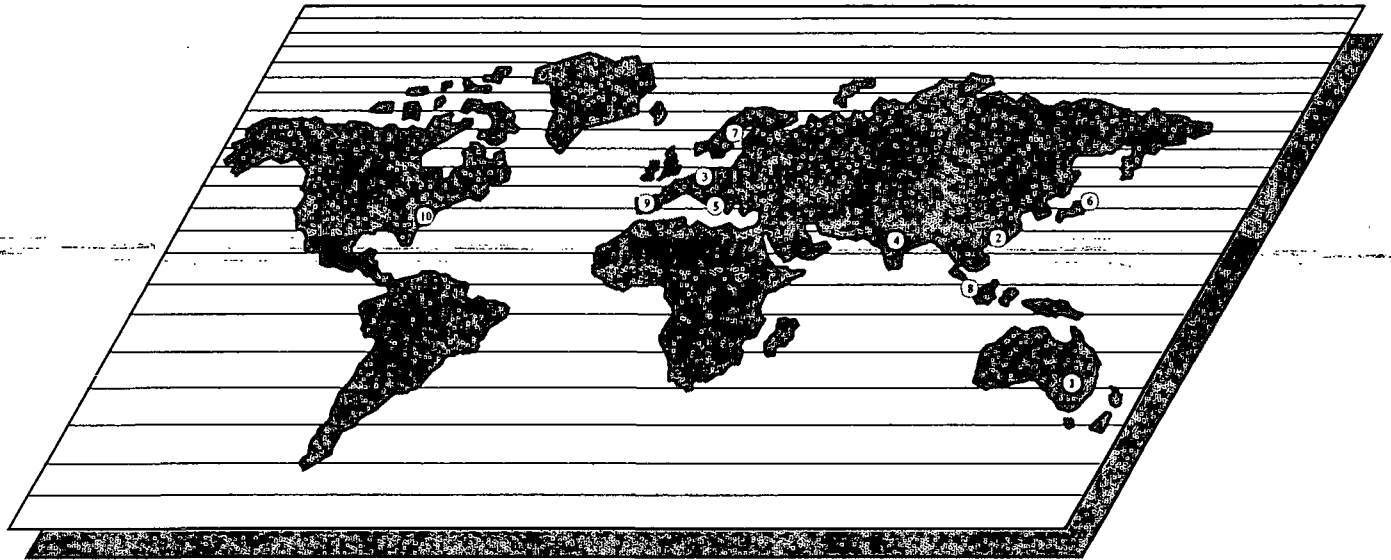
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LINCOLNSHIRE  
PE9 2NB ENGLAND

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Fax: 44 (0) 1780 484100

Web site: [www.newagestamford.com](http://www.newagestamford.com)

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Fax: (61) 2 9680 1545

**2 CHINA:** WUXI NEWAGE ALTERNATORS LIMITED  
Plot 49-A, Xiang Jiang Road  
Wuxi High - Technical Industrial Dev. Zone  
Wuxi, Jiangsu 214028  
PR of China  
Tel: (86) 510 5216212  
Fax: (86) 510 5217673

**3 GERMANY:** NEWAGE ENGINEERS G.m.b.H.  
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Telephone: Hamburg (49) 40 714 8750  
Fax: (49) 40 714 87520

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Telephone: (91) 241 778224  
Fax: (91) 241 777494

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Telephone: Milan (39) 02 380 00714  
Fax: (39) 02 380 03664

**6 JAPAN:** NEWAGE INTERNATIONAL JAPAN  
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Tokyo, 192-03  
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Fax: (81) 426 77-2884

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Fax: (47) 22 97 44 45

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TT International Tradepark  
Singapore 608838  
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Fax: (65) 898 9065  
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Poligono Industrial "Los Linares"  
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E-28970 HUMANES DE MADRID (Madrid)  
Telephone: Madrid (34) 91 604 8987/8928  
Fax: (34) 91 604 81 66

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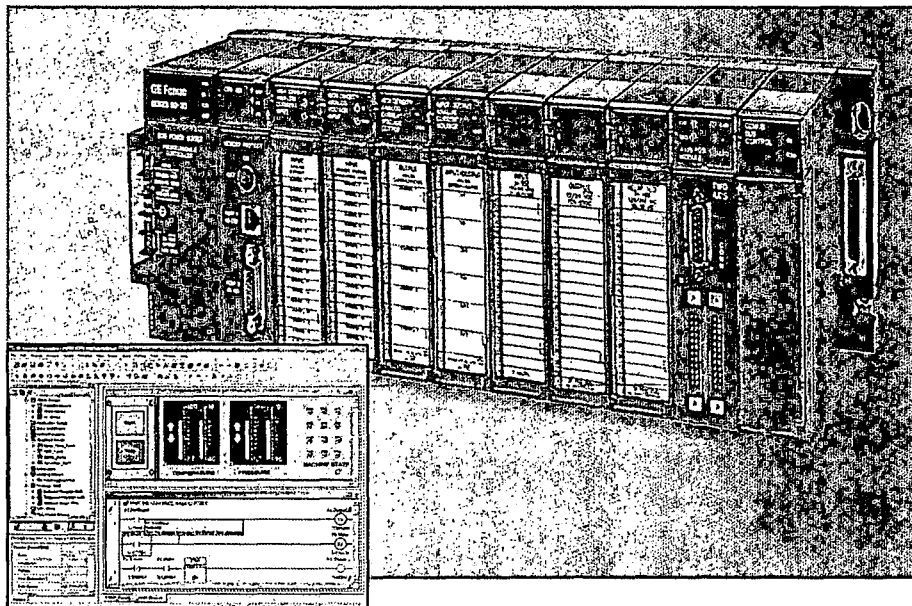




## GE Fanuc Automation

### Series 90™-30 PLCs

The Series 90™-30 PLCs are a family of controllers, I/O systems and specialty modules designed to meet the demand for versatile industrial solutions. With its single overall control architecture, the Series 90-30 has been the PLC of record in over 200,000 applications, such as high-speed packaging, material handling, complex motion control, water treatment, continuous emissions monitoring, mining, food processing, elevator control, injection molding and many more.



Thanks to its modular design, the Series 90-30 offers unmatched versatility. Configure just the system you need, saving critical space and reducing cost.

With over 100 I/O modules, the Series 90-30 PLC can be adapted to a wide range of applications.

- Digital interfaces for push buttons, switches, proximity sensors, relays, contactors and many other devices
- Analog modules with varying degrees of resolution for flow, temperature or pressure applications
- Direct connect wiring or remote termination
- Local or remote I/O systems

**Series 90-30 Ethernet communications** provide a real-time link between the plant floor and the boardroom. You can begin with an Ethernet-enabled CPU, or at a later date, choose from our selection of rack-mounted Ethernet modules. The Series 90-30 Ethernet module supports both SRTCP and Modbus TCP/IP application protocols.

**The scaleable processing power in the Series 90-30 CPU** creates a clear upgrade path. Create the system that's ideal today, while leaving open the option of creating a more powerful system tomorrow — without having to change your application software.

**Motion control integrated into the Series 90-30** fosters high performance point-to-point applications.

**A variety of Series 90-30 field bus interfaces** enables distributed control and/or I/O. Choose from Ethernet EGO, Profibus-DP™, Genius®, DeviceNet™ and Interbus-S™ modules. Field Bus interface modules are easy to install and quick to configure. Plug them into an existing system or design a new system around them.

**Ease of programming is a strong suit of the Series 90-30.** Choose the programming options that meet your needs: Windows®-based IEC programming, advanced C or State Logic®. Floating point math, PID, indirect addressing, array moves and sequencing are just a few of the over 200 instructions available.

**The Series 90-30 stands out among small controls for offering redundancy options.** The Series 90-30 is the low-cost solution for high availability applications, with redundant CPUs and power supplies.

**Easy trouble shooting and machine setup using a handheld PDA.** CIMPLICITY® Machine Edition Logic Developer PDA software allows you to interface a Palm® handheld device to your Series 90-30 controller. With Logic Developer PDA, you can monitor/change data, view diagnostics, force ON/OFF, and configure machine setup, — saving you time and increasing productivity.

## Ordering Information

| Description                            | Catalog Number  | Catalog Number  |
|--|---|---|
| Discrete Input Modules                 | IC693MDL230 120 VAC Isolated Input (8 Points)   | IC693MDL646 24 VDC Input, Neg/Pos Logic, 1 msec Filter (16 Points)  |
|  | IC693MDL231 240 VAC Isolated Input (8 Points)   | IC693MDL648 48 VDC Input, Neg/Pos Logic, 1 msec Filter, Neg/Pos Logic (16 Points)   |
|  | IC693MDL240 120 VAC Input (16 Points)   | IC693MDL653 24 VDC Input, Neg/Pos Logic, 2 msec Filter (32 Points)  |
|  | IC693MDL241 24 VAC/VDC Input (16 Points)  | IC693MDL654 5/12 VDC (TTL) Input, Neg/Pos Logic, (32 Points)  |
|  | IC693MDL632 125 VDC Input (8 Points)  | IC693MDL655 24 VDC Input, Neg/Pos Logic, 1 ms, (32 Points)  |
|  | IC693MDL634 24 VDC Input, Neg/Pos Logic (8 Points)  | IC693ACC300 Input Simulator Module (8 Points)   |
| Discrete Output Modules                | IC693MDL310 120 VAC Output, 0.5 Amp (12 Points)   | IC693MDL740 12/24 VDC Output, 0.5 Amp, Positive Logic (16 Points)   |
|  | IC693MDL330 120/240 VAC Output, 2 Amp (8 Points)  | IC693MDL741 12/24 VDC Output, 0.5 Amp, Negative Logic (16 Points)   |
|  | IC693MDL340 120 VAC Output, 0.5 Amp (16 Points)   | IC693MDL742 12/24 VDC Output, 1 Amp, Positive Logic (16 Points), Fused  |
|  | IC693MDL390 120/240 VAC Isolated Output, 2 Amp (16 Points)  | IC693MDL748 48 VDC Output, 0.5 Amps, Positive Logic (8 Points)  |
|  | IC693MDL730 12/24 VDC Output, 2 Amp, Positive Logic (8 Points)  | IC693MDL750 12/24 VDC Output, Negative Logic (32 Points)  |
|  | IC693MDL731 12/24 VDC Output, 2 Amp, Negative Logic (8 Points)  | IC693MDL751 12/24 VDC Output, Positive Logic (32 Points)  |
|  | IC693MDL732 12/24 VDC Output, 0.5 Amp, Positive Logic (8 Points)  | IC693MDL752 5/12/24 VDC (TTL) Output, Negative Logic, (32 Points)   |
|  | IC693MDL733 12/24 VDC Output, 0.5 Amp, Negative Logic (8 Points)  | IC693MDL753 12/24 VDC Output, Positive Logic (32 Points)  |
|  | IC693MDL734 125 VDC Output (8 Points)   |   |
|  | IC693MDL930 Relay Output, Isolated, 4 Amp (8 Points)  | IC693MDL940 Relay Output, 2 Amp (16 Points)   |
| Relay Output Module                    | IC693MDL931 Relay Output, 8 Amp Form B/C contacts, Isolated in 2 Groups of 4 (8 Points)   |   |
| Mixed Discrete Module                  | IC693MDR390 Mixed I/O, 24 VDC Input (8 points), Relay Output (8 points)   | IC693MAR590 Mixed I/O, 120 VAC Input (8 Points), Relay Output (8 Points)  |
| Analog Input Modules                   | IC693ALG220 Analog Input, Voltage/Current, 4 Channels   | IC693ALG222 Analog Input, Voltage 16 Single/8 Differential Channels   |
|  | IC693ALG221 Analog Input, Current, 4 Channels   | IC693ALG223 Analog Input, Current, 16 Single Channels   |
| Analog Output Modules                  | IC693ALG390 Analog Output, Voltage, 2 Channels  | IC693ALG392 High Density Analog Output (8 Channels)   |
|  | IC693ALG391 Analog Output, Current, 2 Channels  |   |
| Mixed Analog Modules                   | IC693ALG442 Analog Combo Module 4IN/2OUT  |   |
| Motion Modules                         | IC693APU300 High Speed Counter (HSC)  | IC693APU305 High Speed Counter with Gray Code Encoder or an A QUAD B Encoder Input  |
|  | IC693APU301 Axis Positioning Module (APM), 1 Axis   | IC693DSM302 Digital Servo Motion Controller, 2 Axis   |
|  | IC693APU302 Axis Positioning Module (APM), 2 Axis   | IC693DSM314 Digital Servo Motion Controller, 1-2 Axis of Digital Servo or 1-4 Axis Analog Servo   |
|  | IC693MDL750 Solenoid Valve Output (11 Points)/24 VDC Output, 0.5 Amp, Positive Logic (5 Points)                                   | IC693PTM101 Power Transducer Module, CT and PT Interface 120/240 VAC (1m cable)   |
| Specialty Modules                      | IC693PCM301 Programmable Coprocessor Module, 192 KB (47 KB Basic or C Program), 2 Serial Ports                                    | IC693TCM302 Temperature Control Module, (8) TC In and (8) 24 VDC Solid State Outputs  |
|  | IC693PCM311 Programmable Coprocessor Module, 540 KB (640 KB Basic or C Program), 2 Serial Ports                                   | IC693TCM303 Temperature Control Module Extended Temperature Range, (8) TC In and (8) 24 VDC Solid State Outputs   |
|  | IC693PTM100 Power Transducer Module, CT and PT Interface 120/240 VAC (0.5m Cable)   |   |
|  | IC693BEM331 Genius Bus Controller (Supports I/O and Datagrams)  | IC693PBM201 Profibus DP Master Module   |
| Communications Modules                 | IC693CMM302 Communication Module, Genius (1 Xbyte) GCM+ (No Datagram Support)   | IC693PBM201 Profibus DP Slave Module  |
|  | IC693CMM311 Communications Module, CCM, RTU, SNP, and SNPs Protocols  | IC693DNM200 DeviceNet Master Module   |
|  | IC693CMM321 Ethernet Interface TCP/IP Module, 10Mbps (Supports SRTP and Modbus TCP/IP, No EGD)                                    | IC693DNS201 DeviceNet Slave Module  |
| Controllers                            | IC693CPU311 5-Slot Base with CPU in Base (6K Bytes User Program), Not Expandable  | IC693CPU360 CPU 360 Module (240K Bytes Configurable User Memory, 4K I/O, 8 Racks), No Built-In Serial Ports, Logic Execution is 22msec/K  |
|  | IC693CPU313 5-Slot Base with Turbo CPU in Base (Logic Execution is 6 msec), 1K Registers, 112K Bytes User Program, Not Expandable | IC693CPU363 CPU 363 Module (240K Bytes Configurable User Memory, 4K I/O, 8 Racks), 2 Built-In Serial Ports, Logic Execution is 22msec/K   |
|  | IC693CPU323 10-Slot Base with Turbo CPU in Base (Logic Execution is 6 msec) 12Kbytes User Program, Not Expandable                 | IC693CPU364 CPU 364 Module (240K Bytes Configurable User Memory, 4K I/O, 8 Racks), No Built-In Serial Ports, Built-In 10Mbps Ethernet, Supports SRTP, Channels and EGD, Logic Execution is 22msec/K                   |
|  | IC693CPU350 CPU 350 Module (32K Bytes User Memory, 4K I/O, 8 Racks), No Built-In Serial Ports, Logic Execution is 22msec/K        | IC693CPU374 CPU 374 Module (240K Bytes Configurable User Memory), No Built-In Serial Ports, Built-In 10/100Mbps with Built-In Switch, Ethernet Supports SRTP, EGD and No Channel Support, Logic Execution is 22msec/K |
|  |   |   |
| Backplanes                             | IC693CHS391 Base, CPU, 10 Slots, Use with CPU331/CSE331 and above   | IC693CHS397 Base, CPU, 5 Slots, Use with CPU331/CSE331 and above  |
|  | IC693CHS392 Base, Expansion, 10 Slots   | IC693CHS398 Base, Expansion, 5 Slots  |
|  | IC693CHS393 Base, Remote Expansion, 10 Slots (700 ft.)  | IC693CHS399 Base, Remote Expansion, 5 Slots (700 ft.)   |
| Power Supplies                         | IC693PWR321 Power Supply, 120/240 VAC, 125 VDC, Standard, 30 Watts  | IC693PWR332 Power Supply, 12 VDC, High Capacity, 30 Watts   |
|  | IC693PWR322 Power Supply, 24/48 VDC, Standard, 30 Watts   | IC693ACC340 Redundant Power Supply Base (RPSB) with 0.1 meter cable to connect to Power Supply Adapter Module   |
|  | IC693PWR328 Power Supply, 48 VDC, Standard, 30 Watts  | IC693ACC341 Redundant Power Supply Base with 0.5 meter cable to connect to Power Supply Adapter Module  |
|  | IC693PWR330 Power Supply, 120/240 VAC, 125 VDC, High Capacity, 30 Watts   | IC693ACC350 Redundant Power Supply Adapter (RPSA) Module. The RPSA replaces the power supply on a CPU base or expansion base and connects to a Redundant Power Supply Base  |
|  | IC693PWR331 Power Supply, 24 VDC, High Capacity, 30 Watts   | IC693CBL301 Rack to Rack Expansion Cable, 2 Meters  |
|  |   | IC693CBL302 Rack to Rack Expansion Cable, 15 Meters   |
| Accessories                            | IC693ACC301 Replacement Battery, CPU & PCM (Qty. 2)   | IC693CBL312 Rack to Rack Expansion Cable, 0.15 Meters, Shielded   |
|  | IC693ACC302 High Capacity Battery Pack  | IC693CBL313 Rack to Rack Expansion Cable, 8 Meters  |
|  | IC200ACC003 EZ Program Store Flash Device (for CPU374 only)   | IC693CBL314 Rack to Rack Expansion Cable, 15 Meters, Shielded   |
|  | IC693ACC310 Filler Module, Blank Slot   |   |
| Programming and Trouble Shooting Tools | IC693CBL300 Rack to Rack Expansion Cable, 1 Meter   |   |
|  | IC646MP001 Logic Developer - PLC Professional   | IC646MPH101 Logic Developer PDA Software Tool with Cable Adapter  |
| Tools                                  | IC646MPS001 Logic Developer - PLC Standard  |   |
|  |   |   |



## GE Fanuc Automation

GE Fanuc Automation Information Centers

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### Additional Resources

For detailed technical specifications and product ordering information, please visit the GE Fanuc e-catalog at:

[www.gefanuc.com](http://www.gefanuc.com)

GFA-140J  
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# ***GE Fanuc Automation***

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## ***Programmable Control Products***

### ***Series 90<sup>TM</sup>-30 PLC Installation and Hardware Manual***

GFK-0356Q

*August 2002*

GFL-002

## *Warnings, Cautions, and Notes as Used in this Publication*

### **Warning**

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

### **Caution**

Caution notices are used where equipment might be damaged if care is not taken.

### **Note**

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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| Alarm Master         | Field Control    | Modelmaster | Series 90    |
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| CIMPLICITY Control   | Genius           | PowerMotion | Series Six   |
| CIMPLICITY PowerTRAC | Genius PowerTRAC | ProLoop     | Series Three |
| CIMPLICITY 90-ADS    | Helpmate         | PROMACRO    | VuMaster     |
| CIMSTAR              | Logicmaster      | Series Five | Workmaster   |

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## *RFI Standards*

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The Series 90-30 PLC and its associated modules have been tested and found to meet or exceed the requirements of FCC Rule, Part 15, Subpart J. The Federal Communications Commission (FCC) requires the following note to be published according to FCC guidelines.

### **NOTE**

This equipment generates, uses, and can radiate radio frequency energy and if not installed in accordance with this instruction manual, may cause harmful interference to radio communications. It has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules, which are designed to provide reasonable protection against harmful interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

The following note is required to be published by the Canadian Department of Communications.

### **NOTE**

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus set out in the radio interference regulations of the Canadian Department of Communications.

The following statements are required to appear in the *Series 90\_-30 Installation Manual* and the *Series 90\_-30 I/O Specifications Manual* for Class I Div 2 Hazardous Locations.

1. EQUIPMENT LABELED WITH REFERENCE TO CLASS I, GROUPS A, B, C, and D, DIV. 2 HAZARDOUS LOCATIONS IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A, B, C, D OR NON-HAZARDOUS LOCATIONS ONLY.
2. WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2:
3. WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
4. ALL UNUSED SLOTS IN ALL BASEPLATES MUST BE POPULATED WITH FILLER MODULES, IC693ACC310, OR EQUIVALENT.



## Preface

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This manual describes the GE Fanuc Series 90-30 Programmable Logic Controller (PLC). It contains a description of hardware components and provides basic hardware installation procedures. The Series 90-30 PLC is a member of the Series 90\_ family of Programmable Logic Controllers from GE Fanuc.

For a list of product standards, refer to data sheet GFK-0867B or later, *GE Fanuc Approvals, Standards, General Specifications* which lists all of the standards for GE Fanuc products. Installation instructions in this manual are provided for installations that do not require special procedures for noisy or hazardous environments. For installations that must conform to more stringent requirements (such as CE Mark), see GFK-1179, *Installation Requirements for Conformance to Standards*.

## What's New in This Manual

- Added the model 374 CPU, which supports connection to an Ethernet network through two built-in 10BaseT/100BaseTx auto-negotiating full-duplex Ethernet ports. Models 364 (release 9.10 and later) and 374 are the only Series 90-30 CPUs that support Ethernet Global Data. Note that the CPU374 is supported only by the Windows®-based programmers.
- Other corrections and clarifications as necessary.

## Related Publications

For more information on Series 90-30 products, refer to these publications. (For a publication to product catalog number cross-reference refer to Appendix G):

GFK-0255 - Series 90™ PCM and Support Software User's Manual

GFK-0256 - MegaBasic™ Programming Reference Manual

GFK-0293 - Series 90™ -30 High Speed Counter User's Manual

GFK-0401 - Workmaster® II PLC Programming Unit Guide to Operation

GFK-0402 - Series 90™ -30 and 90-20 PLC Hand-Held Programmer User's Manual

GFK-0412 - Genius® Communications Module User's Manual

GFK-0466 - Logicmaster 90™ Series 90™ -30/20/Micro Programming Software User's Manual

GFK-0467 - Series 90™ -30/20/Micro Programmable Controllers Reference Manual

GFK-0487 - Series 90™ PCM Development Software (PCOP) User's Manual

GFK-0499 - CIMPLICITY® 90-ADS Alphanumeric Display System User's Manual

GFK-0356Q

## *Preface*

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GFK-0582 - Series 90™ PLC Serial Communications User's Manual  
 GFK-0631 - Series 90™ -30 I/O LINK Interface User's Manual  
 GFK-0641 - CIMPPLICITY® 90-ADS Alphanumeric Display System Reference Manual  
 GFK-0664 - Series 90™-30 PLC Axis Positioning Module Programmer's Manual  
 GFK-0685 - Series 90™ Programmable Controllers Flow Computer User's Manual  
 GFK-0695 - Series 90™-30 Enhanced Genius) Communications Module User's Manual  
 GFK-0726 - Series 90™-30 PLC State Logic Processor User's Guide  
 GFK-0732 - Series 90™-30 PLC ECLiPS User's Manual  
 GFK-0747 - Series 90™-30 PLC OnTOP User's Guide  
 GFK-0750 - OnTop for Series 90™-30 (State Logic) Program User's Manual  
 GFK-0781 - Motion Mate™ APM300 for Series 90™-30 PLC Follower Mode User's Manual  
 GFK-0823 - Series 90™ -30 I/O LINK Master Module User's Manual  
 GFK-0828 - Series 90™ -30 Diagnostic System User's Manual  
 GFK-0840 - Motion Mate™ APM300 for Series 90™ -30 PLC Standard Mode User's Manual  
 GFK-0867 - GE Fanuc Product Agency Approvals, Standards, General Specifications  
 GFK-0898 - Series 90™ -30 PLC I/O Module Specifications  
 GFK-1028 - Series 90™ -30 I/O Processor Module User's Manual  
 GFK-1034 - Series 90™ -30 Genius® Bus Controller User's Manual  
 GFK-1037 - Series 90™ -30 FIP Remote I/O Scanner User's Manual  
 GFK-1056 - Series 90™ -30 State Logic Control System User's Manual  
 GFK-1186 - TCP/IP Ethernet Communications for the Series 90\_-30 PLC Station Manager Manual  
 GFK-1179 - Series 90™ PLC Installation Requirements for Conformance to Standards  
 GFK-1464 - Motion Mate DSM302 for Series 90™-30 PLCs User's Manual  
 GFK-1466 - Temperature Control Module for the Series 90™-30 PLC User's Manual  
 GFK-1541 - TCP/IP Ethernet Communications for the Series 90™ PLC User's Manual

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# Chapter 1

## Overview of the Series 90-30 PLC

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The Series 90™-30 Programmable Logic Controller (PLC) is a member of the GE Fanuc Series 90 PLC family.

### The Basic Parts of a Series 90-30 PLC

The Series 90-30 PLC is very versatile because (1) it is programmable, and (2) it is assembled from a wide variety of modular, plug-together components. Therefore, by choosing the correct components and developing an appropriate program, the PLC can be used for an almost unlimited variety of applications. Although there are many choices of individual hardware components to use in a system, there are just a few basic categories. Each of these component categories is covered in detail in a separate chapter in this manual. They are introduced in this chapter so you can see how they fit together:

- Baseplates
- Power Supplies
- CPUs
- I/O Modules
- Option Modules
- Cables

#### Baseplates

The baseplates are the foundation of the PLC system because most other components mount on them. As a basic minimum, every system has at least one baseplate, which usually contains the CPU (in which case, it is referred to as “the CPU Baseplate”). Many systems require more modules than can be mounted on one baseplate, so there are also Expansion and Remote baseplates that connect together. The three categories of baseplates, CPU, Expansion, and Remote, are available in two sizes, 5-slot and 10-slot, named according to the number of modules they can hold.

#### Power Supply Modules

Every baseplate must have its own power supply. The power supply always mounts in a baseplate’s left-most slot. There are several power supply models available to meet a variety of requirements.

## **CPU**s

The CPU is the manager of the PLC. Every PLC system must have one. A CPU uses the instructions in its firmware and application program to direct the PLC's operation and to monitor the system to make sure there are no basic faults. Some Series 90-30 CPUs are built into baseplates, but most are contained in plug-in modules. In some cases, the CPU resides in a Personal Computer using a Personal Computer Interface Card that interfaces to Series 90-30 Input, Output, and Option modules.

## **Input and Output (I/O) Modules**

These modules enable the PLC to interface with input and output field devices such as switches, sensors, relays, and solenoids. They are available in both discrete and analog types.

## **Option Modules**

These modules extend the capability of the PLC beyond the basic functions. These provide such things as communications and networking options, motion control, high speed counting, temperature control, interfacing to operator interface stations, etc.

## **Cables**

These connect the PLC components together or to other systems. Many standard prefabricated cables are available from GE Fanuc. They are primarily used to:

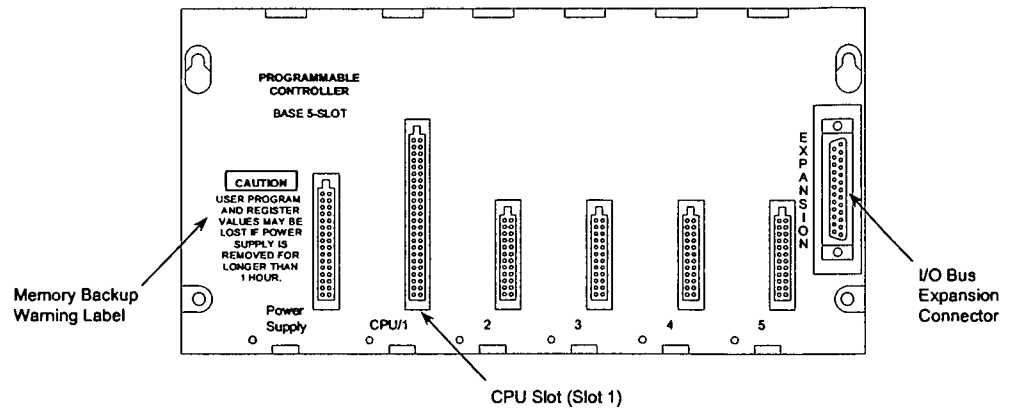
- Interconnect baseplates
- Connect a programmer to the CPU or to an option module
- Connect option modules to field devices or other systems.

## **Assembling a Basic Series 90-30 PLC System**

Let's assemble, on paper, a basic system using the following components:

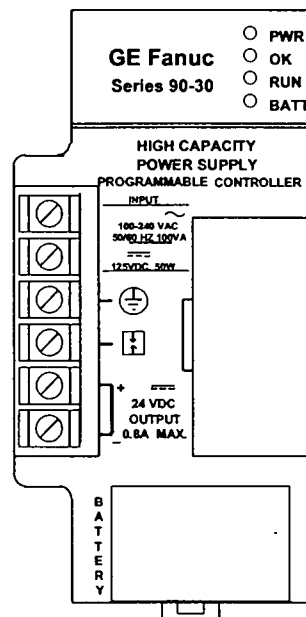
- Baseplate
- Power Supply module
- CPU module
- Some I/O modules

We'll start with the **baseplate**. To keep it simple, we'll use a 5-slot size. Note that a 5-slot baseplate actually has six slots, but the power supply slot is not numbered. Note also, that this baseplate has a CPU slot, which is slot number 1, and it has an expansion connector on the right end, which is used for connecting to another baseplate if the system has more than one baseplate.



**Figure 1-1. Five-Slot CPU Baseplate**

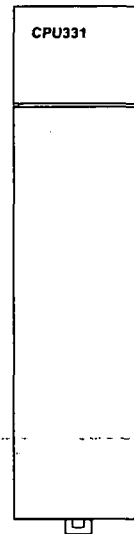
Next, we'll add a **power supply** module. It mounts in the unnumbered slot on the left end of the baseplate. This slot has a unique connector that will only fit a power supply module.



**Figure 1-2. Power Supply Module**

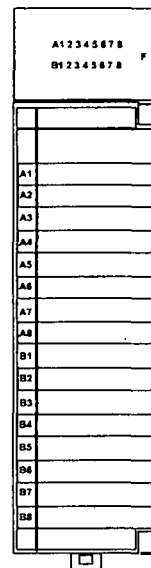
1

Then add a **CPU module**. A CPU module can only mount in baseplate slot 1, next to the power supply. Slot 1 has a unique connector that will only fit CPU or special Option modules.



**Figure 1-3. CPU Module**

To finish, we will add some **I/O modules** to baseplate slots 2 through 5.



**Figure 1-4. I/O Module**

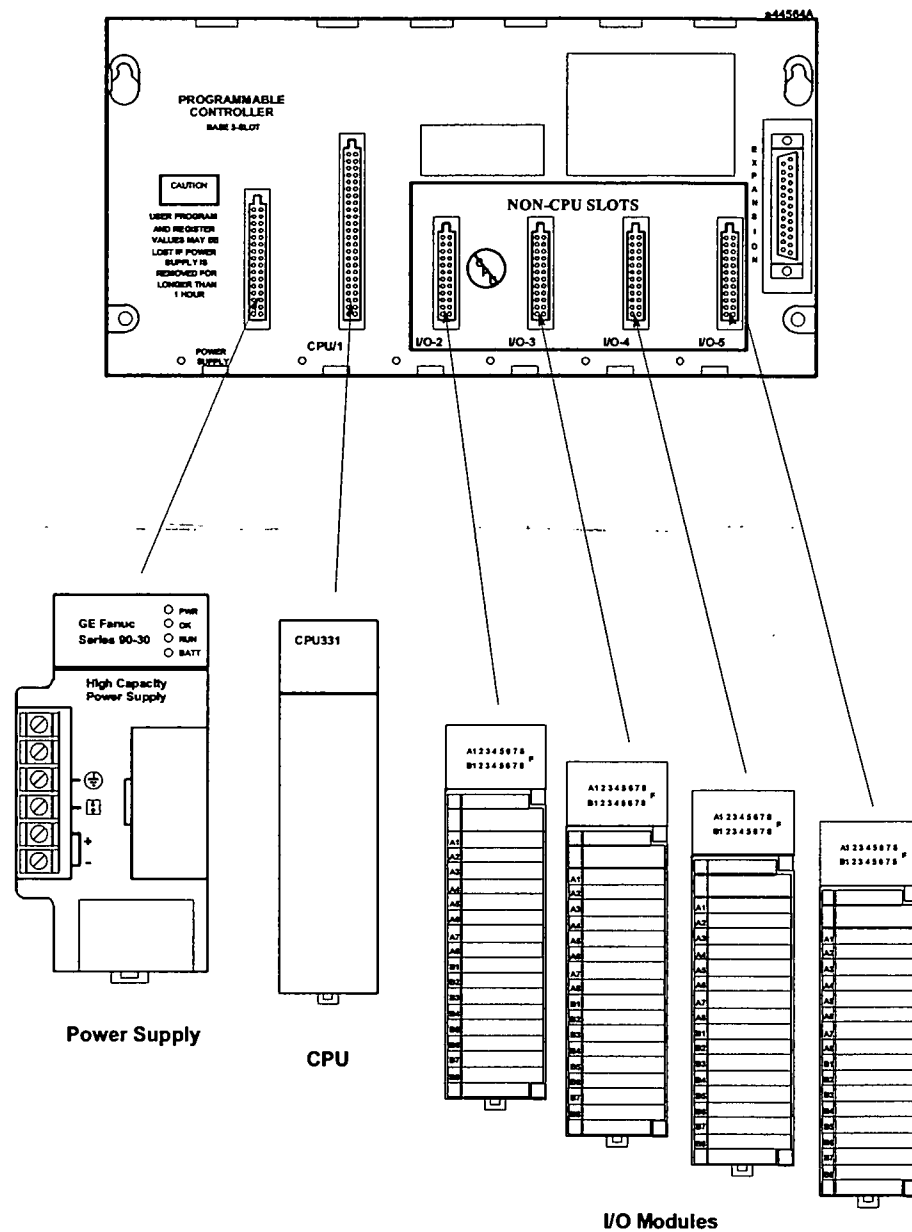
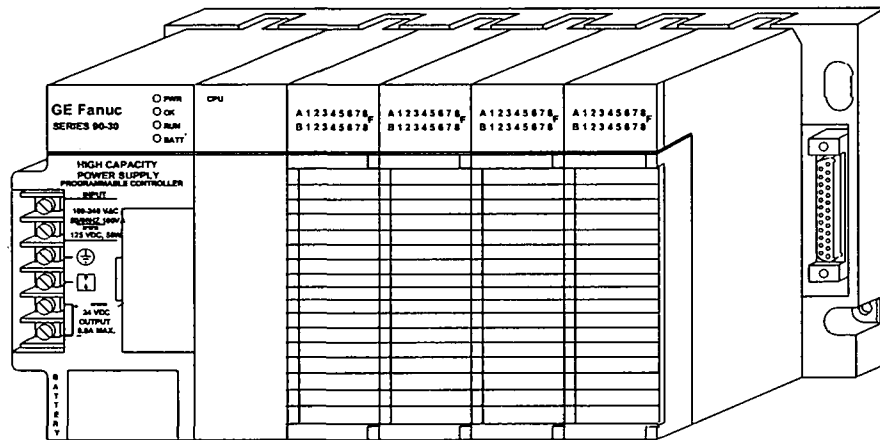


Figure 1-5. Assembling the System

**When assembled, the system will look like this:**



**Figure 1-6. A Basic System**

An assembly of baseplate and modules such as this one is called a “Rack.”

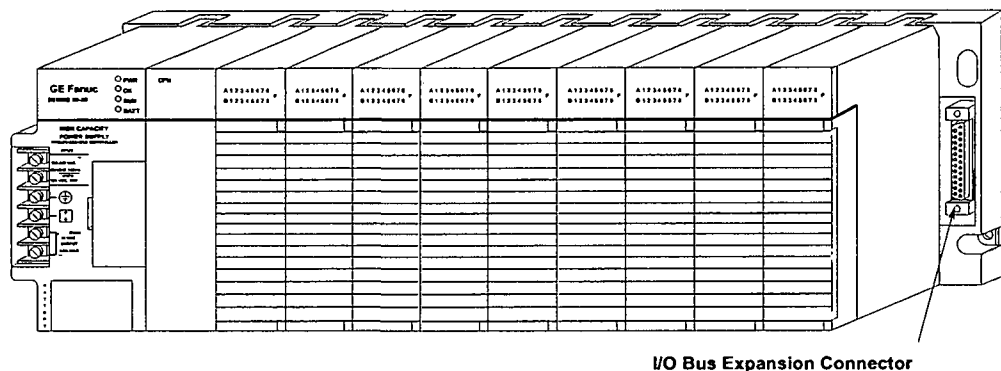
**What else would be needed to make this basic system functional?**

To make this basic system functional, you would need:

- **Mounting.** Safe, secure mounting for the PLC in a protective enclosure.
- **Wiring.** This includes properly installed incoming power to the power supply, as well as wiring from the I/O modules to field devices such as switches, sensors, solenoids, relays, etc.
- **Program.** An application program for the PLC to run. This is developed with GE Fanuc PLC programming software.

**What if the application requires more than five modules?**

You could use a 10-slot baseplate, shown in the next picture:

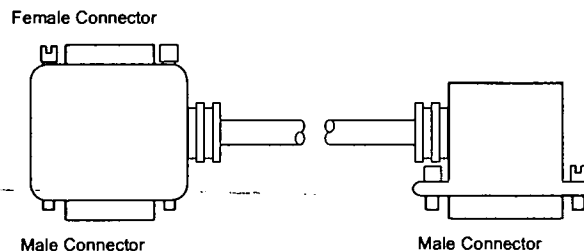


**Figure 1-7. Ten-Slot Rack**

## What if the application requires more than ten modules?

You can add one or more Expansion or Remote racks to this system. Some CPUs can support up to seven additional racks. If you added seven additional 10-slot racks, you could have 70 more modules.

Racks are interconnected in a “daisy-chain” cabling arrangement. This interconnection system is called the “I/O Expansion Bus.” The connections are made from one baseplate’s I/O Bus Expansion Connector (shown in the figure above) to the next one’s. The I/O Bus Expansion Cables, shown below, have a double connector on one end to facilitate these connections.



**Figure 1-8. I/O Bus Expansion Cable**

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The next figure shows a system that has a CPU baseplate, one Expansion rack and three Remote racks. Notice that the last rack, the one at the end of the I/O Expansion Bus, must be terminated. A convenient way of terminating the bus is with an IC693ACC307 I/O Bus Terminator Plug, as shown.

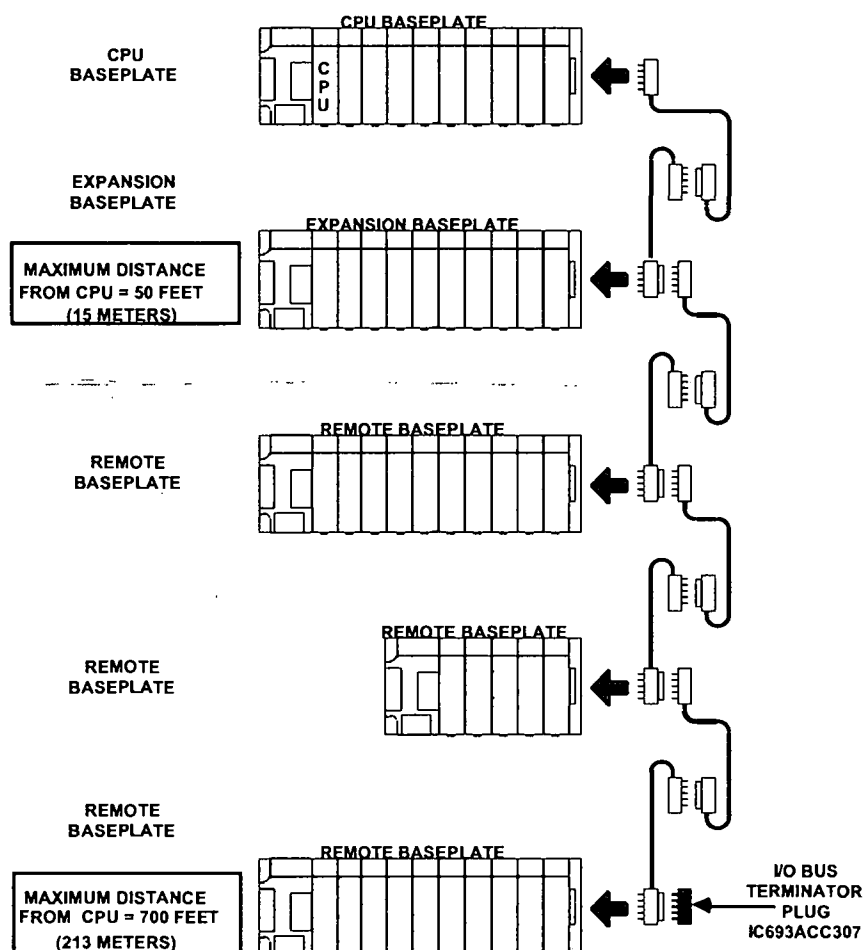


Figure 1-9. Connecting Expansion and Remote Baseplates

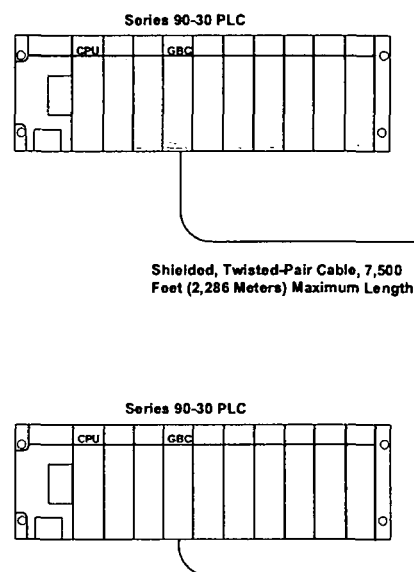
## What is the Difference Between Expansion and Remote baseplates?

The main factor to consider is distance. How far will the baseplate be from the CPU baseplate? If the cabling distance from the CPU baseplate is 50 feet (15 meters) or less, use an Expansion baseplate. The Expansion baseplate is preferable because of its higher communication speed with the CPU baseplate. However, if a baseplate must be located where it requires a cabling distance from the CPU rack in excess of 50 feet, an Expansion baseplate will not work - a Remote baseplate must be used. The limit for a Remote baseplate is a cabling distance of 700 feet (213 meters) from the CPU baseplate to the farthest Remote baseplate.

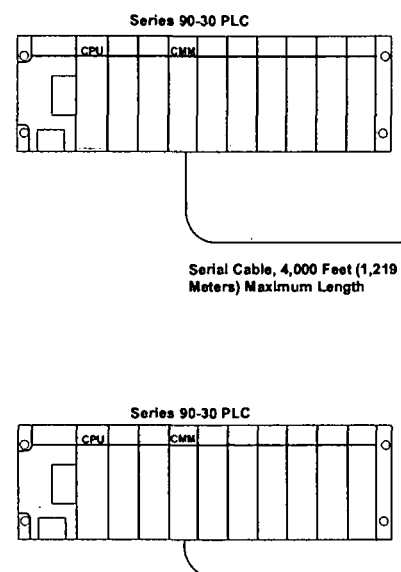
## What if I need to cover more than 700 feet (213 meters)?

You can cover much greater distances by using Series 90-30 communications option modules. For example, Genius Bus Controller Modules (GBC) can communicate at distances up to 7,500 feet (2,286 meters) over a shielded twisted-pair cable, as shown in Example 1 below. Or, serial communications with Communications Coprocessor Modules (CMM) using the RS-485 standard can cover up to 4,000 feet (1,219 meters), as shown in Example 2 below. And virtually unlimited communication distances can be attained with modems and telephone lines or radio transmitters. Also, there are numerous networking options available such as Ethernet or WorldFIP.

**Example 1 - GBC**



**Example 2 - CMM**



**Figure 1-10. Connecting PLCs Using GBC or CMM Modules**

# Chapter 2

## Installation

This chapter discusses installation details only. Other information about the products such as hardware descriptions and specifications, is covered in the applicable chapters.

### Important Note

*Series 90-30 PLCs must be mounted in a protective enclosure.*

*The installation instructions described in this chapter apply to PLC installations that do not require special procedures for noisy or hazardous environments. For installations that must conform to more stringent requirements (such as CE Mark), see GFK-1179, **Installation Requirements for Conformance to Standards**. Also see GFK-0867, **GE Fanuc Product Agency Approvals, Standards, General Specifications**.*

## Receiving your Products - Visual Inspection

When you receive your Series 90-30 PLC system, carefully inspect all shipping containers for damage that may have occurred during shipping. If any part of the system is damaged, notify the carrier immediately. The damaged shipping container should be saved as evidence for inspection by the carrier.

As the consignee, it is your responsibility to register a claim with the carrier for damage incurred during shipment. However, GE Fanuc will fully cooperate with you if such action is necessary.

## Pre-installation Check

After unpacking Series 90-30 PLC racks, cables, modules, etc., **record all serial numbers**. Serial numbers are printed on the module packaging. Serial numbers are required to make a claim during the warranty period of the equipment. All software product registration cards should be completed and returned to GE Fanuc. See "Module Features" in this chapter for location of module serial numbers. See "Common Baseplate Features" in chapter 3 for location of baseplate serial numbers.

You should verify that all components of the system have been received and that they agree with your order. If the parts received do not agree with your order, call Programmable Control Customer Service at 1-800-432-7521. A Customer Service representative will provide further instructions.

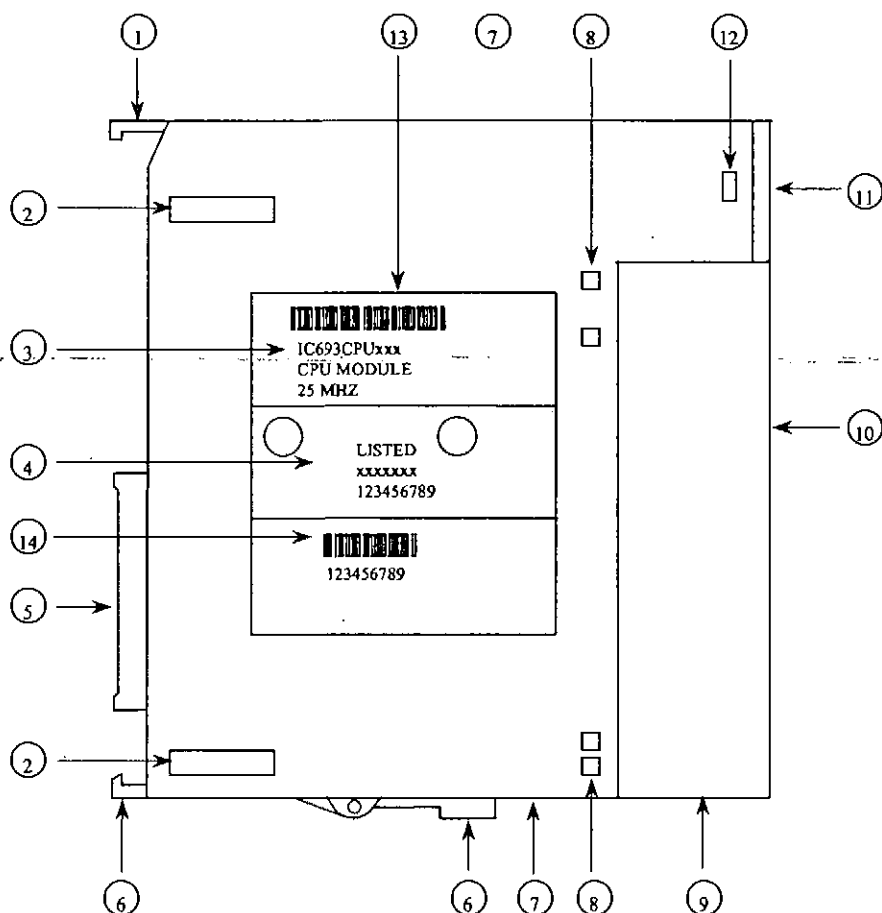
If you require assistance with your installation, GE Fanuc's Technical Support department offers expert help. Call the support number for your area from the list in Chapter 13, "Maintenance and Troubleshooting." The GE Fanuc web site support address is [www.gefanuc.com/support/plc](http://www.gefanuc.com/support/plc).

## Warranty Claims

Record the serial number of the defective item and contact your distributor for instructions.

## Working with Series 90-30 Modules

### Module Features



**Figure 2-1. Features of Series 90-30 Module**

1. Pivot hook
2. Circuit board holding tabs (two on each side of module)
3. Catalog number and description section of label (Includes MAC address for CPU374.)
4. Certification (UL, CE, etc.) section of label
5. Module connector - plugs into baseplate backplane connector
6. Release lever - spring loaded
7. Ventilation openings in module case (top and bottom)
8. Front cover holding tabs (two on each side of module)
9. Front cover (shown) or terminal board (for I/O modules).
10. Front cover faceplate or hinged cover for terminal board.
11. Lens cap (some modules do not have).
12. Lens cap holding tabs (one on each side of module)
13. Module label
14. Serial Number - used to determine module warranty status. (On some modules, the Serial Number may be on a small tag on the back of the module.)

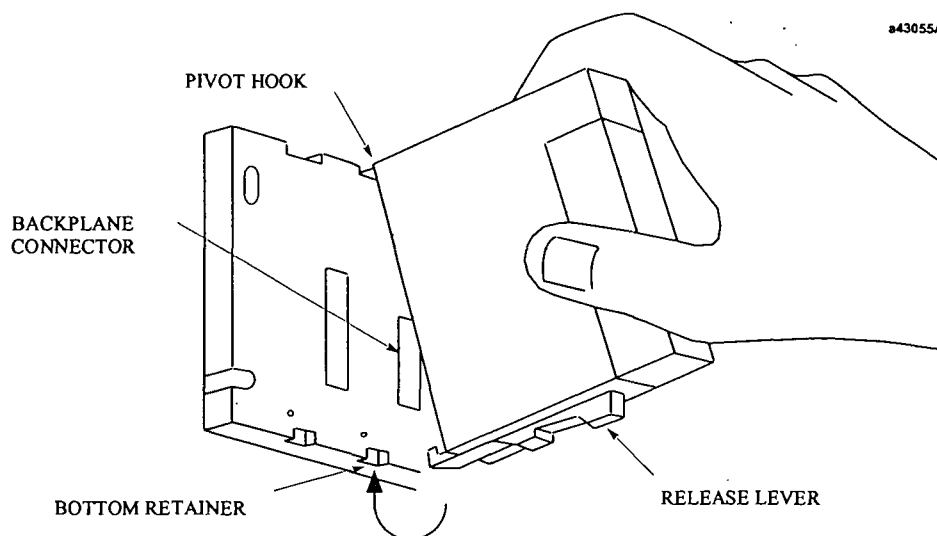
## Installing a Module

### Warning

**Do not insert or remove modules with power applied. This could cause the PLC to stop or malfunction. Injury to personnel and damage to the module or baseplate may result. Also, attempts to force a module into an improper slot type will result in damage to the module and/or the baseplate. Modules will mount in the correct slot type easily, with a minimum of force.**

Use the following instructions as a guide when inserting a module into a baseplate slot.

- Check that module catalog number matches slot configuration. Each slot is, or will be, assigned a particular module type during configuration. A Power Supply module must be installed in the left end unnumbered slot only, and a CPU module and some special Option modules can only be installed in Slot 1 of a CPU-baseplate. I/O Modules and most Option modules install in slots numbered 2 and higher.
- Grasp the module firmly with terminal board toward you and with rear pivot hook facing away from you.
- Align the module with the desired baseplate slot and connector. Tilt the module upwards so that top rear pivot hook of the module engages the baseplate's top module retainer.
- Swing the module downward until the module's connector engages the baseplate's backplane connector, and the release lever on the bottom of the module snaps into place in the baseplate's bottom module retainer.
- Visually inspect the module to be sure that it properly seated.



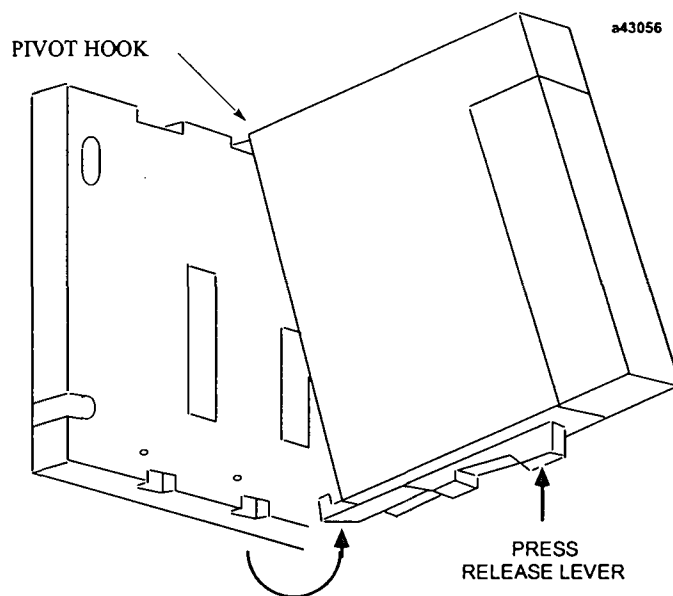
**Figure 2-2. Installing a Module**

## Removing a Module

### Warning

**Do not insert or remove modules with power applied. This could cause the PLC to stop or malfunction. Injury to personnel and damage to the module or baseplate may result. Also potentially dangerous voltages from user devices may be present on a module's screw terminals even though power to the rack is turned off. Care must be taken any time that you are handling the module's removable terminal board or any wires connected to it.**

- If the module has wiring, remove the module's terminal board (NOTE: You do not have to unwire the terminal board) or cables. The procedure for removing a terminal board is described later in this section.
- Locate the release lever at the bottom of the module and firmly press it up, towards the module.
- While holding the module firmly at its top and fully depressing release lever, swing (pivot) the module upward (release lever must be free of its retaining slot).
- Disengage pivot hook at the top rear of the module by moving the module up and away from the baseplate.



**Figure 2-3. Removing a Module**

### Note

Modules in expansion or remote baseplates can be added, removed, or replaced while the PLC is in RUN mode if power is first removed from the expansion or remote baseplate. I/O data to/from this baseplate will not be updated while power is removed.

## Installing a Module's Terminal Board

Note: Modules IC693MDL730F (and later) and IC693MDL731F (and later) have special terminal boards that are equipped with holding screws. For Installation and Removal instructions, please see the section "Installing and Removing Terminal Boards with Holding Screws" later in this chapter.

To install a terminal board (circled numbers refer to drawing below):

- Hook the pivot hook ①, located on the bottom of the terminal board, to the lower slot on the module.
- Push the terminal board toward the module ② until it snaps into place.
- Open the terminal board cover ③ and ensure that the latch on the module is securely holding the terminal board in place.

### Caution

Compare the module catalog number on the label on the back of the hinged door (see Figure 2-6) and the label on the side of the module (see below) to ensure that they match. If a wired terminal board is installed on the wrong module type, damage to the module may occur when the system is powered up.

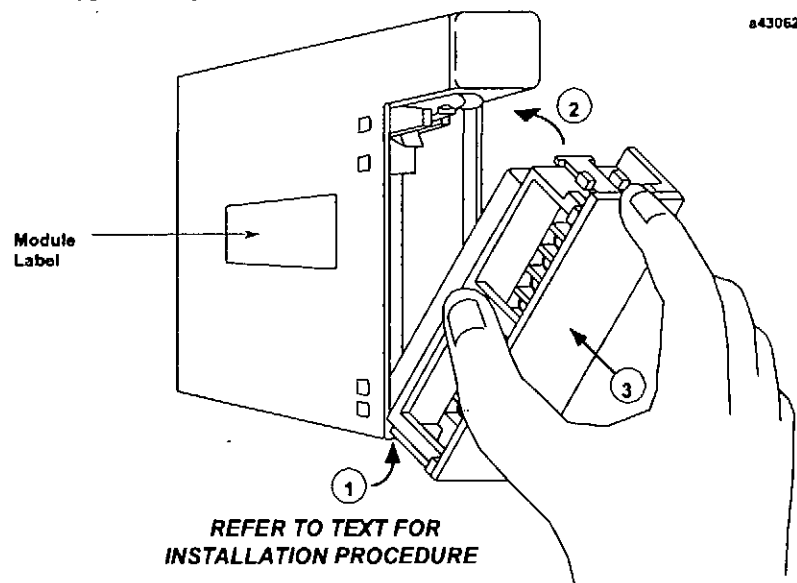
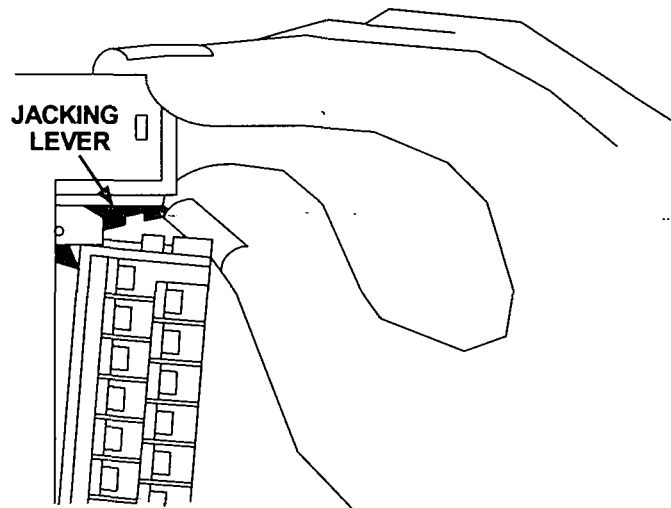


Figure 2-4. Installing an I/O Module's Terminal Board

## Removing a Module's Terminal Board

To remove a terminal board:

- Open the plastic terminal board cover.
- Push up on the jacking lever to release the terminal block.



- Grasp pull-tab and pull it towards you until contacts have separated from module housing and bottom pivot hook has disengaged.

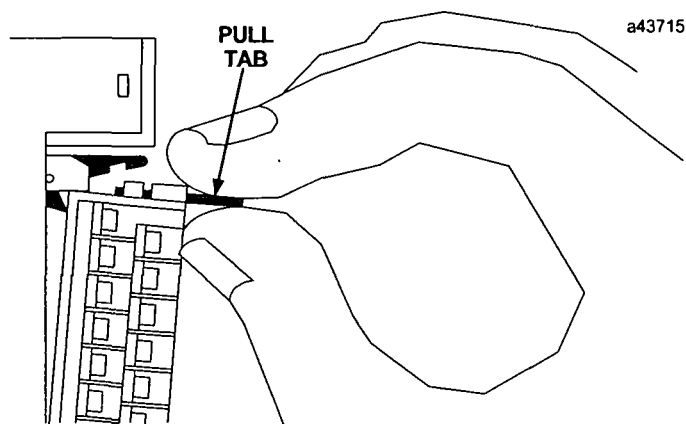


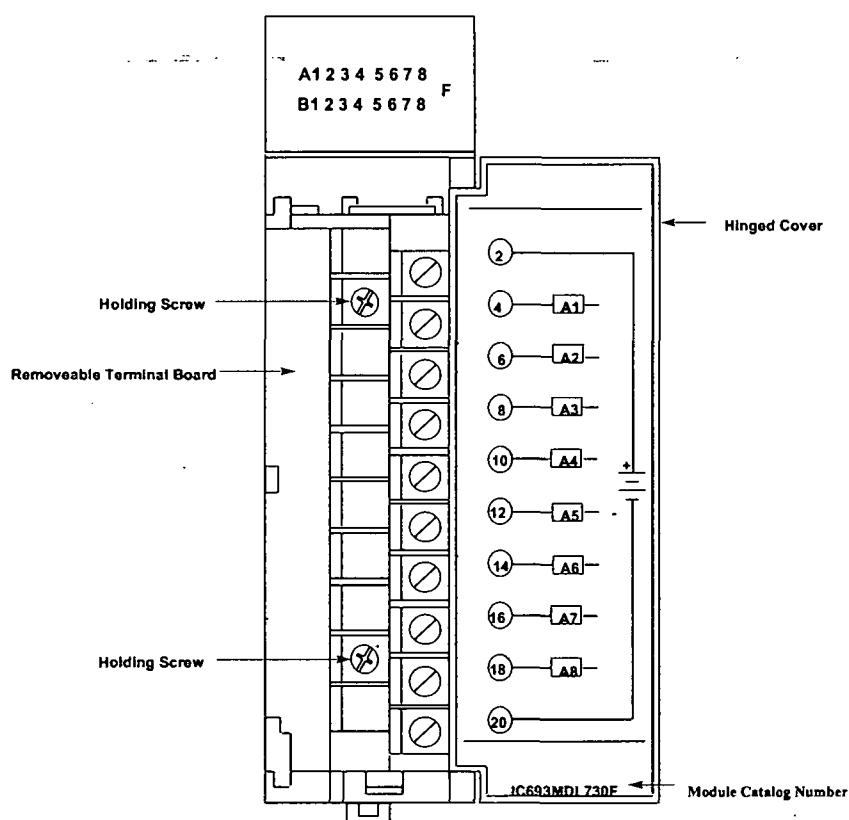
Figure 2-5. Removing a Module's Terminal Board

## I/O Module Terminal Board Posts

The terminal board has three posts on the left side. The top and bottom posts hold the terminal board cover in place. The middle post keeps the terminal board wiring in place. If you do not require it to hold the wiring in place, the middle post can be easily snapped off. (Be careful that you do not inadvertently snap it off if you need it to keep your wiring in place.)

## Installing and Removing Terminal Boards with Holding Screws

Discrete output modules IC693MDL730F (and later) and IC693MDL731F (and later) have a special terminal board that is equipped with holding screws, shown in the figure below. These screws prevent the terminal board-to-module connections from deteriorating in applications where the PLC is subjected to severe vibration.



**Figure 2-6. Terminal Board with Holding Screws**

- **Removing:** To Remove these terminal boards, first loosen the two holding screws on the front of the terminal board, then follow the standard removal instructions in the section “Removing an I/O Module’s Terminal Board.” The holding screws are held captive in the terminal board and do not have to be completely removed.
- **Installing:** To install these terminal boards, follow the standard installation instructions in the section “Installing an I/O Module’s Terminal Board,” then tighten the two holding screws to 8 to 10 inch-pounds (1 Newton-meter) of torque.

## Baseplate Mounting

### Warning

Be sure to follow baseplate grounding instructions in this chapter. Failure to properly ground the PLC can result in improper operation, damage to equipment, and injury to personnel.

### Mounting a Baseplate to a Panel

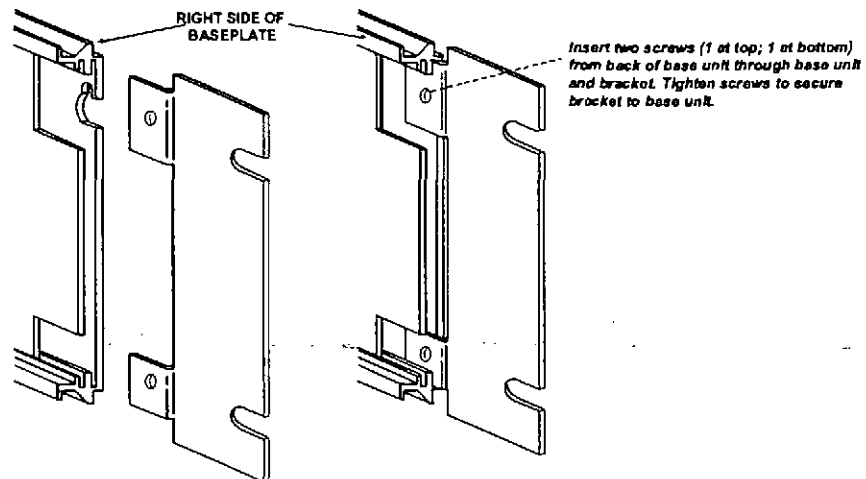
- Use four good-quality 8-32 x 1/2 (4 x 12mm) machine screws, lock washers and flat washers. Install the screws in four tapped holes. The "Baseplates" chapter has the applicable dimensions and mounting clearances. Alternately, 10-slot baseplates can be mounted in standard 19-inch racks by using the appropriate adapter. This is also discussed in the "Baseplates" chapter.
- A vertical mounting orientation is preferred for maximum heat dissipation. Other mounting orientations will require derating the Power Supply current capabilities. See Chapter 12, "System Design," for details.
- All baseplates must be grounded. The "Baseplate Safety Grounding" section of this chapter has details.
- The Rack Number Selection switch must be set on each Expansion or Remote baseplate. A CPU baseplate does not require this switch. Rack numbers should be assigned by the system designer. Failure to set the Rack Number Selection switches properly will result in system malfunction. See the "Baseplates" chapter for details on setting these switches.

### Mounting a Baseplate to a 19" Rack

Two optional Baseplate Adapter Brackets allow a 10-slot baseplate to be mounted in a 19 inch rack. Each baseplate installation requires only one of the adapter brackets.

- **IC693ACC308 Front Mount Adapter Bracket.** Used to mount a baseplate to the front face of a 19" rack. Install the adapter bracket by inserting the tabs at the top and bottom of the adapter bracket into the corresponding slots at the top and bottom of the plastic baseplate cover. NOTE: Although Figure 2-7 shows the plastic baseplate cover removed, this is for illustration purposes only. It is not necessary to remove the cover to install the bracket. With the bracket in place, insert and tighten the two screws (included with the bracket) through the back of the baseplate holes into the threaded holes in the bracket.

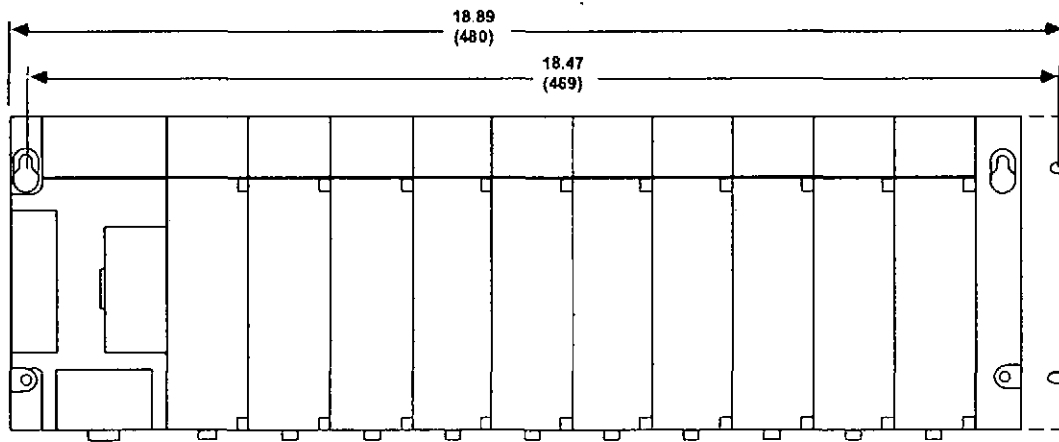
- **IC693ACC313 Recessed Mount Adapter Bracket.** Used to recess mount a baseplate inside a 19" rack. A baseplate mounts on the rear panel of this adapter bracket using four 8-32 (4mm) screws, nuts, lock washers, and flat washers. The Adapter Bracket bolts through its four slotted holes to the face of the 19" rack using applicable hardware (lock washers recommended).



**Note:** Baseplate is shown with cover removed for illustration purposes. It is not necessary to remove the baseplate cover to install the bracket.

**Figure 2-7. IC693ACC308 Front Mount Adapter Bracket Installation**

Dimensions for rack mounting a 10-slot baseplate with the IC693ACC308 Front Mount Adapter Bracket are shown in the following figure.



DIMENSIONS IN INCHES (MILLIMETERS IN PARENTHESES)

**Figure 2-8. Dimensions for 19-inch Rack Mounting Using IC693ACC308 Adapter Bracket**

2

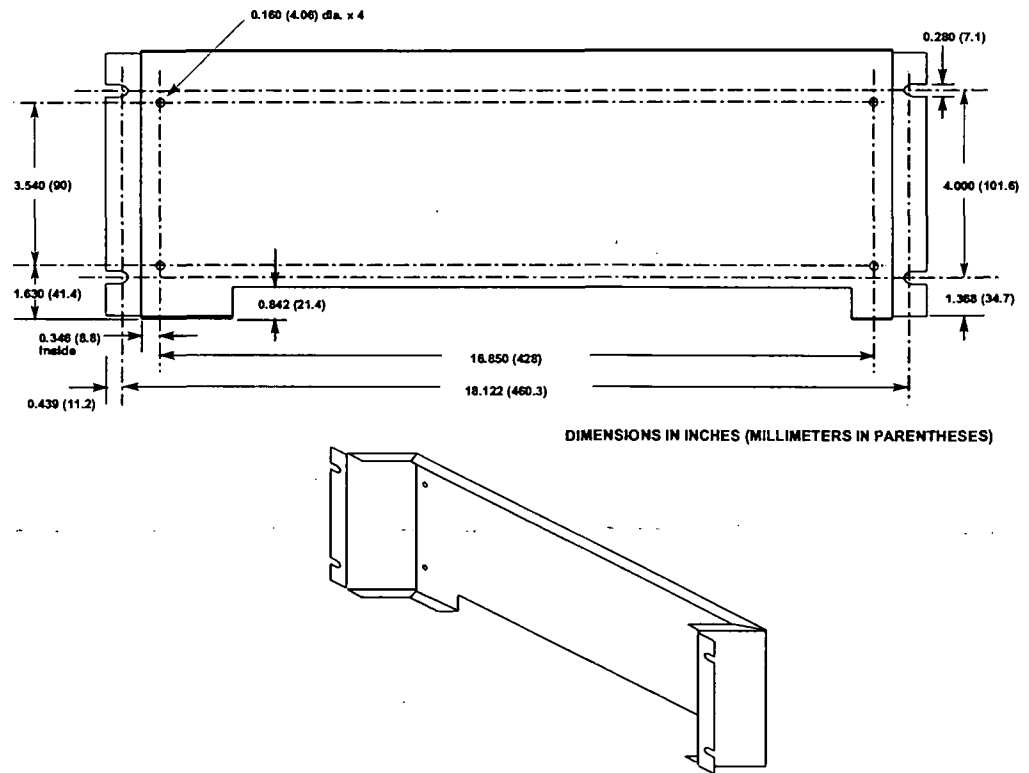


Figure 2-9. IC693ACC313 Recessed Mount Adapter Bracket

## Grounding Procedures

### System Grounding Procedures

#### Warning

In addition to the following grounding information, we strongly urge that you follow all applicable codes that apply to your area. For example, in the United States, most areas have adopted the National Electrical Code standard and specify that all wiring conform to its requirements. In other countries, different codes will apply. For maximum safety to personnel and property you must follow these codes. Failure to do so can mean injury or death to personnel, damage to property, or both.

All components of a programmable logic control system and the devices it is controlling must be properly grounded. This is particularly important for the following reasons.

- A low resistance path from all parts of a system to earth minimizes exposure to shock in the event of short circuits or equipment malfunction.
- The Series 90-30 PLC system requires proper grounding for correct operation.

### Ground Conductors

- Ground conductors should be connected in a tree fashion with branches routed to a central earth ground point, shown in the figure below. This ensures that no ground conductor carries current from any other branch. This method is shown in the following figure.
- Ground conductors should be as short and as large in size as possible. Braided straps or ground cables (typically green insulation with a yellow tracer - AWG #12 (3.3 mm<sup>2</sup>) or larger) can be used to minimize resistance. Conductors must always be large enough to carry the maximum short circuit current of the path being considered.

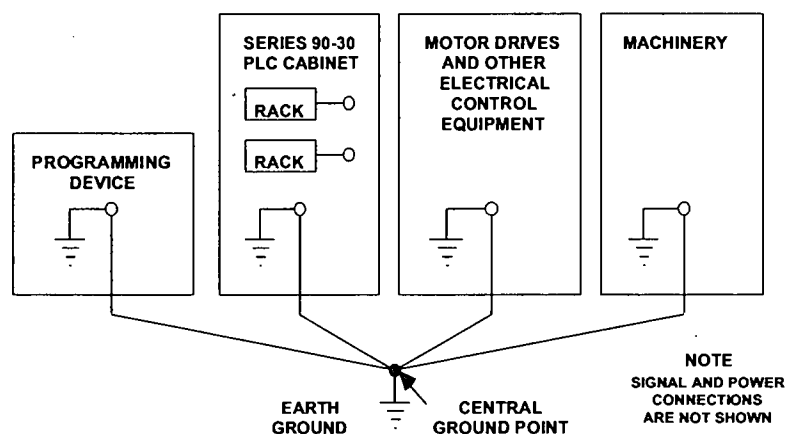


Figure 2-10. Recommended System Grounding

## Series 90-30 PLC Equipment Grounding

Equipment grounding recommendations and procedures are listed below. These grounding procedures must be properly followed for safe, proper operation of your Series 90-30 PLC system.

### Baseplate Safety Grounding

The following recommendations are offered, but applicable safety codes for your area or equipment type should also be consulted. The baseplate's metal back must be grounded using a separate conductor; the baseplate mounting screws are not considered to an acceptable ground connection by themselves. Use a minimum AWG #12 (3.3 mm<sup>2</sup>) wire with a ring terminal and star lock washer under the head of one of the baseplate's two lower mounting holes. These two holes have openings to the side to allow connecting a wire and ring terminal under the head of a mounting screw. Connect the other end of this ground wire to a tapped hole in the panel that the baseplate is mounted to, using a machine screw, star lock washer, and flat washer. Alternately, if your panel has a ground stud, it is recommended you use a nut and star lock washer for each wire on the ground stud to ensure adequate grounding. Where connections are made to a painted panel, the paint should be removed so clean, bare metal is exposed at the connection point. Terminals and hardware used should be rated to work with the aluminum baseplate material.

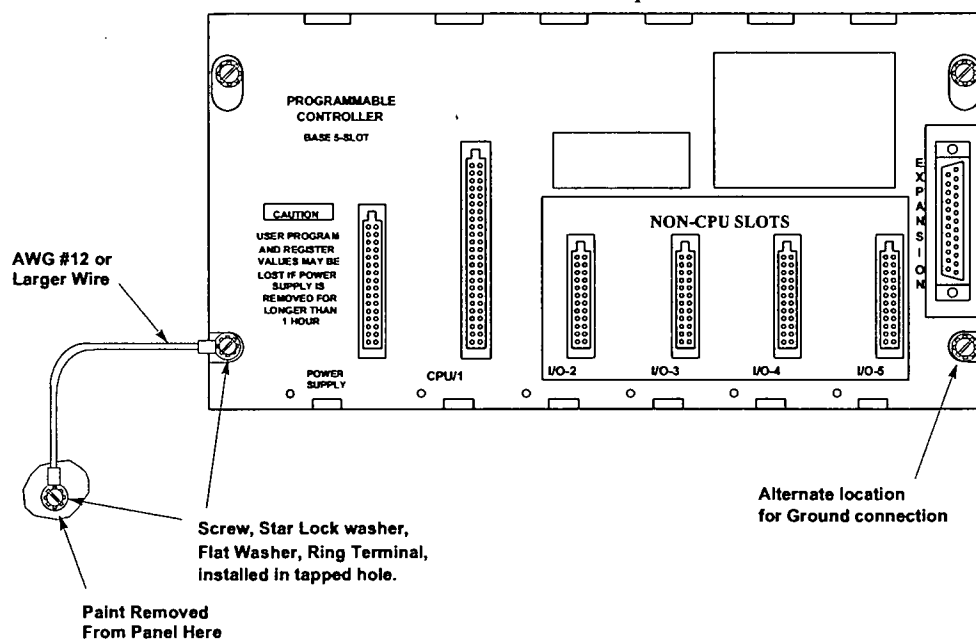


Figure 2-11. Baseplate Grounding

### Warning

All baseplates must be grounded to minimize electrical shock hazard. Failure to do so can result in severe personal injury.

All baseplates grouped together in a Series 90-30 PLC system must have a common ground connection. This is especially important for baseplates that are not mounted in the same control cabinet.

## Grounding 19" Rack-Mounted Baseplates

There are two Adapter Brackets used for mounting a 10-slot Series 90-30 baseplate to a 19" Rack. Regardless of which of the two Adapter Brackets is used, the 19" Rack should be grounded as per the instructions in "System Grounding Procedures," including Figure 2-10. (For details on the Adapter Brackets, see the "Mounting a Baseplate to a 19" Rack" section earlier in this chapter.)

Nineteen-Inch Rack-mounted PLC baseplates should be grounded according to the guidelines in the "Baseplate Safety Grounding" section, using a separate ground wire from the PLC baseplate as shown in the previous figure (Fig. 2-11).

- If using the **Recessed Mount Adapter Bracket (IC693ACC313)**, the ground wire can be installed as shown in Figure 2-11 with the ground attached to the Recessed Mount Adapter Bracket. An additional ground wire connecting the Adapter Bracket to a solid chassis ground on the 19" Rack should be installed. Use the same or equivalent hardware and paint removal scheme as shown in Figure 2-11.
- If using the **Surface Mount Adapter Bracket (IC693ACC308)**, the ground wire should be run from the baseplate as shown in Figure 2-11, to a solid chassis ground on the 19" Rack. Use the same or equivalent hardware and paint removal scheme as shown in Figure 2-11.

## Programmer Grounding

For proper operation, the computer (programmer) running the PLC software must have a ground connection in common with the CPU baseplate. Normally, this common ground connection is provided by ensuring that the programmer's power cord is connected to the same power source (with the same ground reference point) as the baseplate. If it is not possible to ensure this common ground scheme, use a port isolator (IC690ACC903) between the programmer and PLC serial connection. If the programmer ground is at a different potential than the PLC ground, a shock hazard could exist. Also, damage to the ports or converter (if used) could occur when the programmer serial cable is connected between the two.

### Warning

**Failure to follow programmer grounding recommendations could result in personal injury, equipment damage, or both.**

## Module Shield Grounding

In general, the aluminum PLC baseplate is used for module shield grounding. On some Series 90-30 modules, shield connections to the user terminal connector on the module are routed to the baseplate through the module's backplane connector. Other modules, such as CPUs 351, 352, 363, 364, and 374 require a separate shield ground. These are discussed in the next several sections.

### Shield Grounding Information for CPUs with External Port Connections

CPUs with external port connections, the 351, 352, 363, 364, and 374 must have a separate shield ground connection to provide shielding for these ports. Because the design of the ground connection for the CPU351 and 352 is different from that of the CPU363, 364, and 374, each grounding method is discussed in a separate section.

#### CPU351 and 352 Shield Grounding

The CPU 351 or 352 module must be connected to frame ground at the slot where it is installed. Two methods are provided for making this ground connection. Each CPU comes with an EMC Grounding Kit (44A737591-G01) that contains a ground wire, grounding bracket, and screws.

1. The connection from the CPU to frame ground can be made using the ground wire (part number 44A735970-001R01) that comes with the module in the EMC Grounding Kit. This wire has a stab-on connector on one end for connection to a mating terminal on the bottom of the CPU, and a ring terminal on the other end for connection to a grounded enclosure. Where the ring terminal contacts a painted enclosure panel, either a star lock washer can be installed between the terminal and the panel to cut through the paint, or the paint can be scraped away down to clean, bare metal to ensure a good contact. **Note: The star lock washer method is suitable for a shield ground, but not suitable for a safety ground.**

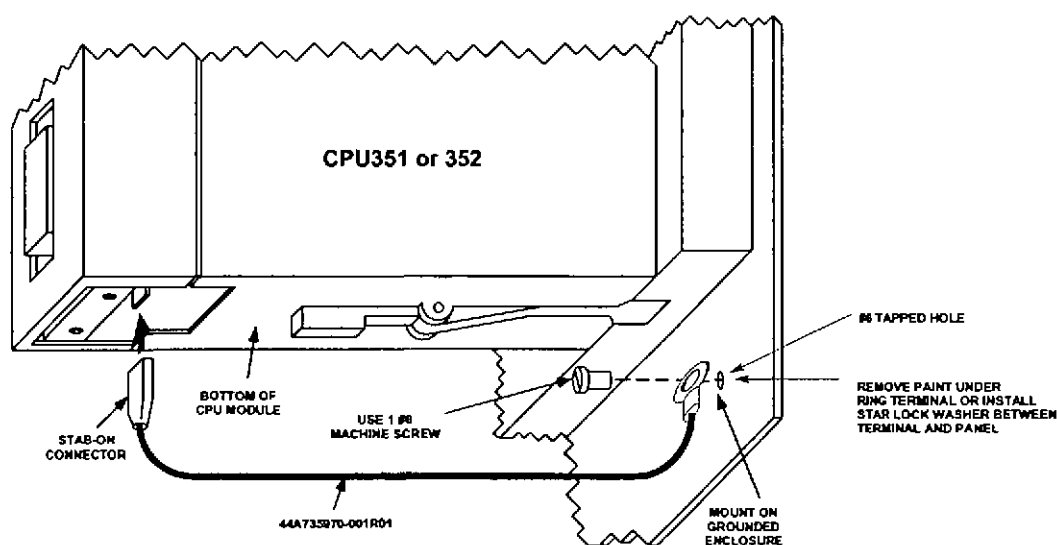
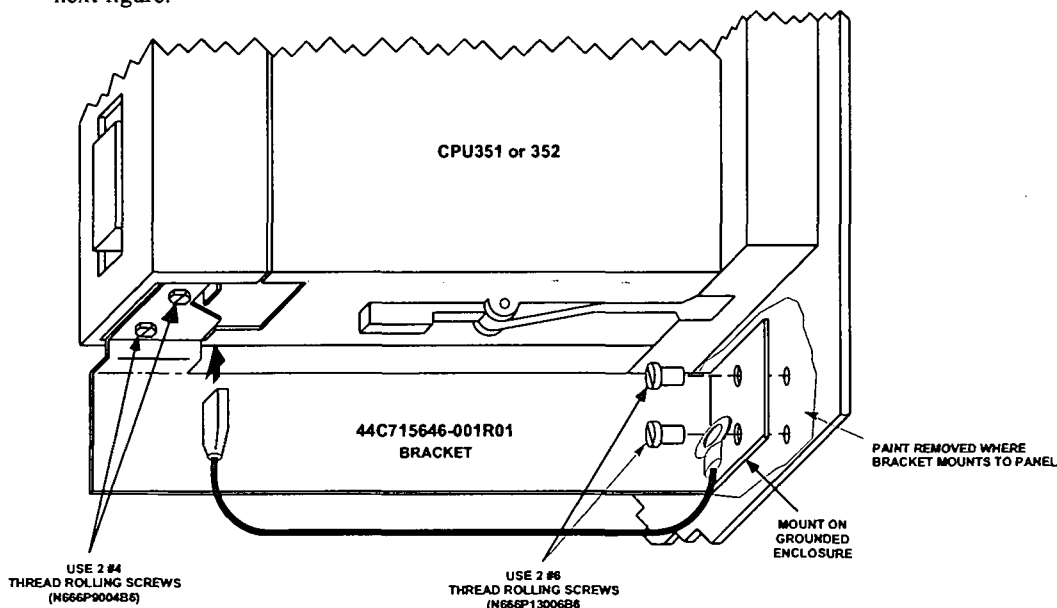


Figure 2-12. CPU 351 or 352 - Attaching Shield Ground Wire

2. The second method, which can be used for systems in noisy environments consists of installing the green ground wire **and** the optional grounding bracket (part number 44C715646-001R01). This bracket attaches to the CPU using two #4 thread-rolling screws (part number N666P9004B6) and to the grounded enclosure using two #6 thread-rolling screws (part number N666P13006B6). Two holes must be drilled in the enclosure for mounting this bracket. Also, if the bracket will be attached to a painted surface, the paint should be removed down to bare metal under the bracket to ensure good contact between the bracket and the surface. See the next figure.



**Figure 2-13. CPU 351 or 352 - Mounting the Shield Grounding Bracket and Wire**

**Note:** When the grounding bracket is used, pin 1 of the cable connector that plugs into the Port 2 connector should not be connected. A metal connector shell must be used on the cable for this port, and the cable shield must be terminated at the metal shell instead of pin 1 of the connector.

## CPU363, CPU364, and CPU374 Shield Grounding

The CPU363, CPU364, and CPU374 modules must be connected to frame ground at the slot where they are installed. Each module comes with a grounding wire for this purpose. These modules do not support or require the use of a grounding bracket. If the ring terminal on the grounding wire is to be mounted to a painted surface, remove the paint under the ring terminal to ensure good contact, or place a star lock washer between the ring terminal and the painted surface. See the next figure.

**Note:** The star lock washer method is suitable for a shield ground, but not suitable for a safety ground.

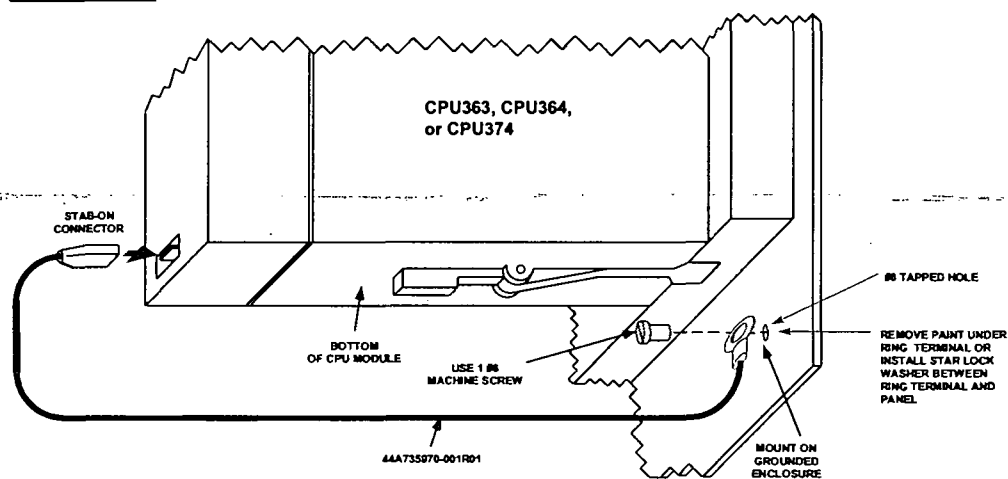


Figure 2-14. CPU 363, CPU364, or CPU374 - Attaching Ground Wire

## Additional Modules with Shield Grounding Requirements

Some of the Series 90-30 Option modules, such as the FIP Remote I/O Scanner (IC693BEM330), and DSM modules (IC693DSM302 and IC693DSM314) also have shield grounding requirements. These modules come equipped with suitable grounding hardware. Please refer to each module's user's manual for grounding instructions. Appendix G contains a product to publication cross-reference to help you identify the correct manual.

## General Wiring Guidelines

### Warning

In addition to the following wiring suggestions, we strongly urge that you follow all wiring and safety codes that apply to your area or your type of equipment. For example, in the United States, most areas have adopted the National Electrical Code standard and specify that all wiring conform to its requirements. In other countries, different codes will apply. For maximum safety to personnel and property you must follow these codes. Failure to do so can lead to personal injury or death, property damage or destruction, or both.

### Color Coding Wires

These color codes are commonly-used in industrial equipment manufactured in the United States. They are cited here as a reference. Where they are in conflict with codes that apply to your area or your type of equipment, you should follow your applicable codes instead. Besides satisfying code requirements, wire color coding makes testing and troubleshooting safer, faster, and easier.

- Green or green with stripe- Ground
- Black - Primary AC
- Red - Secondary AC
- Blue - DC
- White - Common or neutral
- Yellow - Secondary power source not controlled by the main disconnect. Alerts maintenance personnel that there may be power present (from an external source) even if the equipment is disconnected from its main power source.

### Wire Routing

To reduce noise coupling among PLC wires, it is recommended you keep electrically noisy wiring, such as AC power wiring and Discrete Output Module wiring, physically separated from low-level signal wiring such as DC and Analog Input module wiring or communications cables. This can be accomplished by grouping separately, where practical, the following categories of wiring:

- **AC power wiring.** This includes the AC input to the PLC power supply, as well as other AC devices in the control cabinet.
- **Analog Input or Output Module wiring.** This should be shielded to further reduce noise coupling. See the *Series 90-30 I/O Module Specifications Manual*, GFK-0898 for details.
- **Discrete Output Module wiring.** These often switch inductive loads that produce noise spikes when switched off.
- **DC Input Module wiring.** Although suppressed internally, these low-level inputs should be further protected against noise coupling by observing these wiring practices.
- **Communications Cables.** Wiring such as Genius Bus or serial cables should be kept away from noise-producing wiring.

Where AC or Output wiring bundles must pass near noise-sensitive signal wiring bundles, avoid running them beside each other. Route them so that, if they have to cross, they do so at a right angle. This will minimize coupling between them.

### Grouping Modules to Keep Wires Segregated

If practical, grouping similar modules together in the PLC racks can help keep wiring segregated. For example, one rack could contain only AC modules, and a different rack only DC modules, with further grouping in each rack by input and output types. For smaller systems, as an example, the left end of a rack could contain Analog modules, the middle could contain DC modules, and the right end could contain AC modules.

## Discrete I/O Module Connection Methods

- For modules with 16 points or less, the standard method is to use the removable terminal board which comes with these modules. The removable terminal board makes it easy to prewire field wiring to the user supplied input and output devices, and to replace modules in the field without disturbing existing field wiring.
- Some discrete 16-point I/O modules can be used with an optional Terminal Block Quick Connect (TBQC) assembly. This assembly contains a module faceplate, with built-in connector, that replaces the removable terminal board. The assembly also contains a DIN-rail mounted terminal block and a cable to connect the module to the terminal block. The advantage of this method is that it saves about two hours of wiring time per module compared with hand wiring from a module's removable terminal board to a user-supplied, panel-mounted terminal block or strip.
- Older 32-point I/O modules have one 50-pin connector on the front of the module that is either connected by a cable with a connector on each end to a Weidmuller panel-mounted terminal block (Weidmuller catalog no. 912263), or is connected by a cable with stripped, tinned leads to a user-supplied terminal block or strip.
- Newer 32-point I/O modules have two 24-pin connectors on the front of the module. These module may be wired in one of three ways. (1) Use a pair of cables (IC693CBL327/328 - see data sheet in "Cables" chapter) to connect the module to a user-supplied, panel-mounted terminal block or strip. These cables have a 24-pin connector on one end, and stripped, tinned leads with wire markers on the other end. (2) Use a pair of dual-connector cables to connect the module to a Terminal Block Quick Connect (TBQC) terminal block (IC693ACC377). See Appendix H for details. (3) Make your own custom cables. Instructions are found in the IC693CBL327/328 data sheet in Chapter 10.

## Connections to I/O Module Terminal Boards

Series 90-30 PLC I/O terminal boards have either 10 or 20 screw terminals that will accept from two AWG #22 (0.36 mm<sup>2</sup>) to two AWG #16 (1.3 mm<sup>2</sup>), or one AWG #14 (2.1 mm<sup>2</sup>) copper 90°C (194°F) wire(s). Each terminal can accept solid or stranded wires, but the wires into any given terminal should be the same type (both solid or both stranded) to ensure a good connection. Wires are routed to and from the terminals out of the bottom of the terminal board cavity. The suggested torque for the I/O terminal board connection screws is from 9.6 in-lbs to 11.5 in-lbs (1.1–1.3 Newton-meters).

For 24 volt DC input modules, an internal 24 volt power connection is provided on the terminal board to supply a limited number of input devices. Also, a 24 volt DC output is available on the power supply module's terminal board to supply a limited number of output devices.

## Terminal Block Quick Connect Installation for 16-Point Discrete Modules

The Terminal Block Quick Connect (TBQC) Assembly is an option for certain Series 90-30 discrete I/O modules. See Appendix H for more information.

- Remove standard terminal board from module.
- Install TBQC faceplate (it has a 24-pin connector).
- Mount the TBQC terminal block. It has a 24-pin connector and a terminal strip, and mounts on a standard 35 mm DIN-rail.
- Connect a TBQC cable between the TBQC faceplate connector on the module and the connector on the TBQC terminal block.
- Wire I/O devices to the terminal block.

## Installation of 32-Point Discrete, 50-Pin Connector Modules

These 50-Pin modules are an older design and are not generally used on new systems, unless to fulfill standardization requirements. They are mainly used as replacements for existing installations. For new installations, we recommend the dual 24-pin connector style because they have additional features not found on the older modules (LED indicators, TBQC), and it is much easier to fabricate custom-length cables for them. Installation information is provided here for the convenience of those still using these modules.

### Using Weidmuller #912263 Terminal Block

Note: The TBQC is not available for these modules, but you may purchase a Weidmuller #912263 from your electronics distributor for this application.

- Mount the Weidmuller#912263 terminal block. It has a 50-pin connector and a terminal strip, and mounts on a standard 35 mm DIN-rail.
- Connect an IC693CBL306/307 cable between the module's faceplate connector and the connector on the Weidmuller terminal block. See Chapter 10 for cable data.
- Wire I/O devices to the terminal block. See the *Series 90-30 PLC I/O Module Specifications Manual*, GFK-0898, for pin-out information.

## Using a Generic Terminal Block or Strip

- Mount terminal block/strip to the enclosure panel.
- Connect an IC693CBL308 or 309 cable, or a custom made cable, to the module's faceplate connector and wire the stripped ends of the cable to the terminal block/strip. See Chapter 10 for cable data.
- Wire I/O devices to the terminal block/strip.

## Direct Method

- Connect an IC693CBL308 or 309 cable, or a custom made cable, to the module's faceplate connector and wire the stripped ends of the cable directly to the field devices. See Chapter 10 for cable data. See the Series 90-30 PLC I/O Module Specifications Manual, GFK-0898, for pin-out information.

## Installation of Discrete 32-Point, Dual 24-Pin Connector Modules

### Using a TBQC

- Mount two TBQC terminal blocks. Each has a 24-pin connector and a terminal strip, and mounts on a standard 35 mm DIN-rail.
- Connect a pair of TBQC cables (IC693CBL329 - 334) between the module's faceplate connector and the connectors on the two TBQC terminal blocks. Note that both a right side and left side cable is required. See Appendix H for a list of cables.
- Wire I/O devices to the terminal blocks. See the Series 90-30 PLC I/O Module Specifications Manual, GFK-0898, for pin-out information.

The Terminal Block Quick Connect (TBQC) Assembly is an option for certain Series 90-30 discrete I/O modules. See Appendix H for more information.

### With a Generic Terminal Block/Strip

- Mount terminal block/strip to the enclosure panel.
- Connect an IC693CBL327/328 cables, or a custom made cables, to the module's faceplate connectors, and wire the stripped ends of the cables to the terminal block/strip. Note that both a right side and left side cable is required. See Appendix H for a list of cables. See Chapter 10 for cable data sheets.
- Wire I/O devices to the terminal block/strip. See the Series 90-30 PLC I/O Module Specifications Manual, GFK-0898, for pin-out information.

## Direct Method

- Connect an IC693CBL327/328 cable, or a custom made cable, to the module's faceplate connectors, and wire the stripped ends of the cable directly to the field devices. See Chapter 10 for cable data. See the *Series 90-30 PLC I/O Module Specifications Manual*, GFK-0898, for pin-out information.

## General Wiring Methods for Analog Modules

Twisted, shielded instrumentation cable is strongly recommended for analog module input or output signal connections. Proper grounding of the shield is also important. For maximum electrical noise suppression, the cable shield should only be grounded at one end of the cable. For Input modules, ground the end that is in the noisiest environment (which often is at the field device end). For Output modules, ground at the module end. See GFK-0898, *Series 90-30 PLC I/O Module Specifications*, for more shield grounding information.

## Analog Input Module Wiring Methods

Correcting electrical noise problems can sometimes be a trial-and-error routine. However, in general, it is generally best to ground the cable shield as close to the source of the noise as possible, which is usually at the device end. In troubleshooting noise problems, sometimes it is beneficial to experiment with the shield grounding point location. Remember, the cable shield should be grounded at one end only. Also, it is best to keep the length of stripped cable leads as short as possible to minimize the length of unshielded conductors that will be exposed to the noisy environment. See the *Series 90-30 PLC I/O Module Specifications Manual*, GFK-0898 for additional details.

## Using a Generic Terminal Block or Strip

- Mount a terminal strip inside the control enclosure and run a shielded cable from the terminal strip to each input circuit on the module's terminal board terminals.
- Connect each cable's shield to the metal panel next to the terminal strip. Do not connect the shields at the module end (cut shield off at module end of cable and insulate with shrink tubing).
- Wire the field device to the terminal strip with a shielded cable, grounding the shield at the device end only (cut shield off at terminal strip end of cable and insulate with shrink tubing). Also, keep the length of exposed (outside of shield) leads at the terminal strip and device ends as short as possible.

## Direct Method

- Run a shielded cable from the field device (transducer, potentiometer, etc.) directly to the module.
- Connect the conductors to the applicable screws on the module's terminal board.

- Ground the shield at the field device end, exposing a minimum amount of conductor to the noisy environment. Do not connect the shield at the module end (cut shield off at module end of cable and insulate with shrink tubing).

## TBQC not Recommended for Analog Modules

The Terminal Block Quick Connect (TBQC) Assembly is not recommended for use with analog modules due to cable shielding requirements.

## Analog Output Module Wiring

### General

Each output should be connected using a good quality shielded wire with the cable shield grounded at the module end. See GFK-0898, *Series 90-30 PLC I/O Module Specifications*, for more information.

### Using a Generic Terminal Block or Strip

- Mount a terminal strip inside the control enclosure and run a shielded cable from the terminal strip to each output circuit on the module's terminal board terminals.
- Ground each cable's shield at the module end only. Do not connect the shields at the terminal strip end (cut shields off at terminal strip end of cables and insulate with shrink tubing).
- Wire the field device to the terminal strip with shielded cables, grounding the shields at the terminal strip end only (cut shields off at field device end of cables and insulate with shrink tubing). Also, keep the length of exposed (outside of shield) leads at the terminal strip and device ends as short as possible.

### Direct Method

- Run a shielded cable from each field device (transducer, potentiometer, etc.) directly to the module.
- Connect the conductors to the applicable screws on the module's terminal board.
- Ground the shield at the module end only, exposing a minimum amount of conductor to the noisy environment. Do not connect the shield at the device end (cut shield off at device end of cable and insulate with shrink tubing).

## TBQC not Recommended for Analog Modules

The Terminal Block Quick Connect (TBQC) Assembly is not recommended for use with analog modules due to cable shielding requirements.

## AC Power Source Connections

### AC Input Wiring to AC/DC Power Supplies

#### Warning

If the same AC power source is used to provide AC power to other baseplates in a Series 90-30 PLC System, ensure that all AC input connections are identical at each rack. Do not cross Line 1 (L1) and Line 2 (L2). A resulting difference in potential can injure personnel or cause damage to equipment. Each baseplate must be connected to a common ground.

Ensure that the protective cover is installed over all terminal boards. During normal operation with an AC power source either 120 VAC or 240 VAC is present on the AC Power Supply. The cover protects against accidental-shock-hazard which could cause severe or fatal injury to the operator or maintenance personnel.

Both the Standard (IC693PWR321) and High Capacity (IC693PWR330) AC/DC power supplies currently have six terminals for user connections. Early versions of some Series 90-30 power supplies had five terminals (see next figure). The wiring methods for both five-terminal and six-terminal types is similar, except that step 3 below does not apply to the five-terminal type.

The power supply terminal boards will accept one AWG #14 (2.1 mm<sup>2</sup>) or two AWG #16 (1.3 mm<sup>2</sup>) copper 75\_C (167\_F) wires. Each terminal can accept solid or stranded wires, but the wires in any given terminal should be the same type. The suggested torque for the power supply terminal board is 12 in-lbs (1.36 Newton-meters). Open the door protecting the terminal board and make the following connections from the AC power source, and ground connections (system grounding requirements are described in detail later in this chapter).

1. These are wide range supplies that can operate from an AC power source within the nominal range of 100 VAC to 240 VAC at 50/60 Hz. This may vary -15% to +10% for a total maximum range of 85 VAC to 264 VAC. These are auto-ranging supplies that do not require jumper or switch settings for selection of power source voltage.
2. Connect the hot and neutral wires or lines L1 and L2 to the upper two terminals on the terminal board. Connect the safety ground wire to the ground terminal, which is the third terminal from the top, and is marked with a ground symbol.
3. For power supplies with six terminals, the factory jumper between the 3rd and 4th terminals (see figure below), should be left in place for normal installations. However, this jumper must be removed and external surge suppressors installed in installations with a "Floating Neutral" input. Please see the section "Special Instructions for Floating Neutral (IT) Systems" later in this chapter for details.
4. After all connections to Power Supply terminal board have been completed, the protective cover plate should be carefully reinstalled.

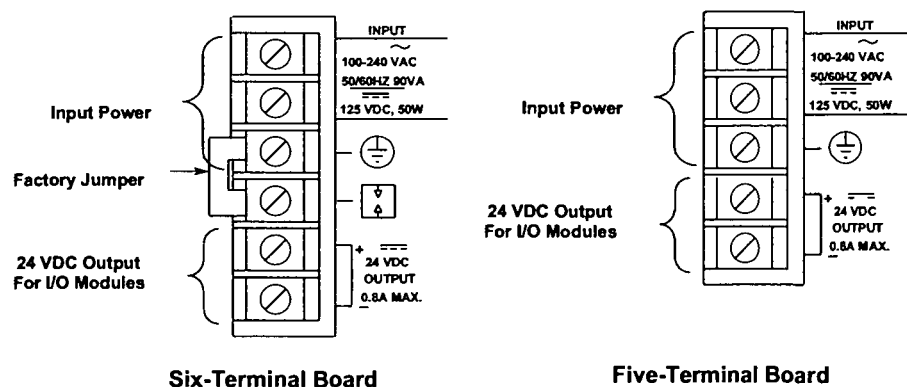


Figure 2-15. Power Supply Terminal Boards

## Power Supply Overvoltage Protection Devices

The overvoltage protection devices for this power supply are connected internally to pin 4 on the user terminal board. This pin is normally connected to frame ground (pin 3) with the supplied jumper strap which is installed at the factory. If overvoltage protection is not required *or* is supplied upstream, this feature can be disabled by leaving pin 4 unconnected by removing the jumper strap. Also, this jumper must be removed and external surge suppressors installed in installations with a "Floating Neutral" input, please see the following section "Special Instructions for Floating Neutral (IT) Systems" later in this chapter.

If you want to Hi-pot test this supply, overvoltage protection *must be disabled* during the test by removing the terminal board strap. Re-enable overvoltage protection after testing by reinstalling the strap.

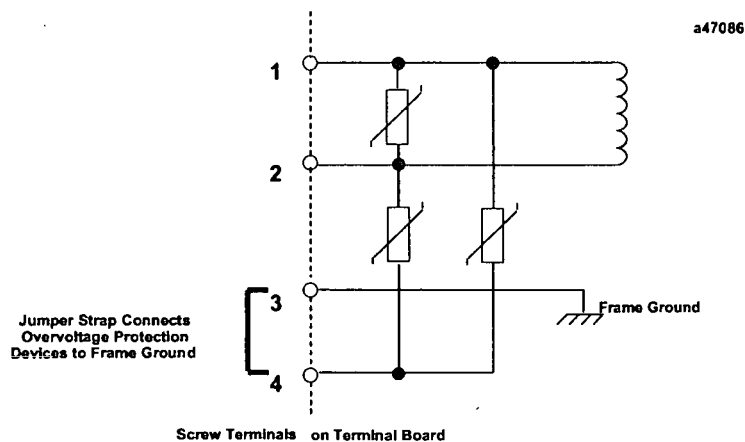


Figure 2-16. Overvoltage Protection Devices and Jumper Strap

## Special Installation Instructions for Floating Neutral (IT) Systems

When the AC input power supplies listed below are installed in a system where the Neutral line is **not** referenced to Protective Earth Ground, these special installation instructions must be followed to prevent damage to the power supply.

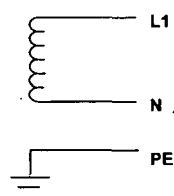
IC693PWR321S (or later version)

IC693PWR330A (or later version)

### Definition of Floating Neutral Systems

A *Floating Neutral System* is a system of power distribution wiring where Neutral and Protective Earth Ground are **not** tied together by a negligible impedance. In Europe this is referred to as an IT system (see IEC950). In a *Floating Neutral System*, voltages measured from input terminals to protective earth ground may exceed the 264 Volts AC maximum input voltage specified in the power supply specifications in Chapter 24 in this manual.

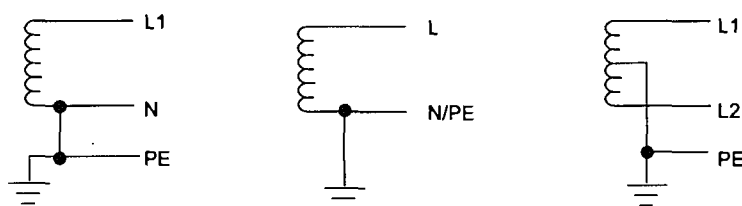
### Example of Floating Neutral System



This system **must** be installed using the special installation instructions on the following page.

Systems in which one leg of the power distribution wiring is tied to Protective Earth or a tap between two legs of the power distribution wiring is tied to Protective Earth are **not** *Floating Neutral Systems*.

### Examples of Non-Floating Neutral System



These non-floating neutral systems **do not** require these special installation instructions.

## Use These Special Installation Instructions for Floating Neutral Systems

1. The input power terminals should be wired according to the instructions in the “AC Power Source Connections” section of this chapter.
2. The factory installed jumper between terminals 3 and 4 of the Power Supply module **must** be removed if using one of the Power Supplies that have this feature. See the “Overvoltage Protection Devices” section of the “Power Supplies” chapter for details.
3. Voltage surge protection devices, such as MOVs, **MUST** be installed between the following terminals:
  - From L1 to earth ground
  - From L2 (Neutral) to earth ground

The voltage surge devices must be rated such that the system is protected from power line transients that exceed  $\text{Line voltage} + 100V + (N-PE)_{MAX}$ .

The expression  $N-PE$  refers to the voltage potential between neutral and Protective Earth (PE) ground.

For example, in a 240 Volt AC system with neutral floating 50V above earth ground, the transient protection should be rated at:

$$240V + 100V + 50V = 390V$$

## DC Power Source Connections

### DC Input Wiring to AC/DC and DC-Only Power Supplies

DC Input power can range from 12 to 30 VDC for the 24 VDC supply, 18 to 56 VDC for the 24/48 VDC supply or 100 to 150 VDC for the 125 VDC supply. All Series 90-30 power supplies have DC input capabilities. The following connection information applies to all of them:

Connect the + and - wires from the power source to the top terminals on the terminal board (+ to the top terminal, - to the second terminal). Connect the third terminal from the top to system ground.

### +24 VDC Output (All Supplies)

The bottom two terminals are connected to the isolated 24 volt DC output that can be used to supply power to input circuits (within power limitations of the supply).

#### Warning

If the same DC input power source is used to provide power to two or more power supplies in a Series 90-30 PLC System, ensure that connection polarity is identical at each rack (top terminal + and second terminal -). Do not cross the Positive (+) and Negative (-) lines. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each baseplate must be connected to a common system ground, described earlier in this chapter.

## Basic Installation Procedure

**Note:** Series 90-30 PLCs must be mounted in a protective enclosure. The enclosure should be capable of properly dissipating the heat produced by all of the devices mounted inside it. For details on calculating heat dissipation, refer to Appendix F.

The system design, which includes producing the layout and wiring drawings, should be completed before beginning the installation procedure. This section offers a basic step-by-step approach to installing a Series 90-30 PLC system. Some steps refer to earlier sections of this chapter for additional details. An attempt was made to place the steps in an order that will make the process as efficient as possible. However, due to the wide variance in system designs, this order may not be the most efficient for your system, so you may wish modify this procedure to fit your needs.

1. Gather the schematics, layouts, prints, and other information for the job.

### Warning

**To avoid the possibility of electrical shock to personnel or damage to your PLC, we recommend that you shut off all power to the system before mounting and wiring the PLC. Also, keep all electronic components away from the area while drilling and tapping to keep metal chips and filings out of these sensitive components.**

2. From the layout drawing, determine where the baseplate(s) will be mounted. Lay out the hole locations, either using the dimensions given on your layout drawing or from the "Baseplates" chapter of this manual.
3. Mark the hole locations for the baseplate safety ground wire (see "Baseplate Safety Ground" in this chapter).
4. Mark the hole locations for module shield ground connections (if any). See "Module Shield Ground" (and accompanying sections) in this chapter for instructions.
5. Finish laying (marking hole locations) out the rest of the system. This includes any terminal blocks you will be using. DIN-rail mounted terminal blocks for some of the 32-point I/O modules are manufactured by Weidmuller. DIN-rail mounted GE Fanuc Terminal Block Quick Connect (TBQC) assemblies are optional for some of the 16-point and 32-point discrete I/O modules. If using these TBQCs, refer to Appendix H for data. Also, APM and DSM modules use DIN-rail mounted terminal blocks.

### Note

We recommend drilling and tapping all holes before mounting any components. This will avoid getting chips and filings in the components.

6. Drill and tap the marked holes. For baseplate mounting, use 8-32 or 4mm size.
7. Mount the baseplates. Use good quality 8-32 x 1/2 inch or 4 x 12mm size screws. We recommend using star lock washers and flat washers under the screw heads (star lock washer should be located between screw head and flat washer) to ensure a tight baseplate ground connection, and to keep the screws from loosening. Connect each baseplate ground wire as shown in the "Baseplate Safety Ground" section of this chapter.
8. If you have Expansion or Remote racks, determine the correct rack number for each one, then set the rack numbers using the Rack Number Selection dual in-line package (DIP) switch on

the baseplate. Please refer to the “Baseplates” chapter for details on setting these DIP switches. Rack numbers should be assigned by the system programmer because they correspond to system configuration settings and program memory addressing.

9. If you have more than one baseplate (rack), connect the I/O Bus Expansion Cables between the I/O Bus Expansion Connectors, which are located on the right end of the baseplates. The cables are connected in a “daisy-chain” arrangement from one baseplate to the other. This is made possible by the fact that the cables have a dual connector on one end. Therefore, when the cable is plugged into a baseplate connector, the second connector on that end of the cable provides a socket for connecting to the next cable. The data sheet for the I/O Bus Expansion cables (IC693CBL300 etc.) in the “Cables” chapter has sample wiring figures.
10. On the last I/O Bus Expansion Connector, plug in an I/O Bus Expansion Terminator, Catalog Number IC693ACC307 (unless using a cable with built-in terminator resistors, which would either be GE Fanuc cable IC693CBL302, or your own custom-built cable).
11. Install the modules in their correct slots using your system layout drawings. (The label on the side of each module identifies the module type and catalog number.) Refer to the section “Installing Modules” if you are not familiar with how to do this.
12. Connect cables to Option modules. Route cables away from noise-producing wires. See the “Wire Routing” section of this chapter.
13. Be sure to follow the information in the “Wiring Guidelines” section of this chapter to protect the system from electrical noise. Install the power wires to the Power Supply and I/O modules:
  - **I/O modules with removable terminal boards.** You can wire the terminal boards in-place on the modules or remove them from the modules before wiring. Although removing them may help make wiring easier (a previous section “Working with Removable Terminal Boards” shows how to remove a terminal board), care should be taken to avoid mixing them (each terminal board has the catalog number of the module printed on it, and the hinged cover has a wiring diagram for that module type). If you are using wire duct, routing each module’s wires through the opening in the duct directly under the module will help to keep each terminal board in its correct position.
  - **I/O Modules with terminal blocks.** Some modules use terminal blocks that mount to the enclosure panel. This includes all 32-point modules and, can include other I/O modules if they are fitted with the optional Terminal Block Quick Connect Assembly. Connect the terminal blocks to the connectors on the modules with the provided cables.
14. Connect the signal (switches, sensors, solenoids, etc.) wires to the terminal boards, or terminal blocks/strips. If wiring to terminal boards, these can be removed for ease of wiring, if desired. See the section “Removing a Module’s Terminal Board.”
15. When finished wiring the I/O terminal boards (if used and if you removed them for ease of wiring), re-install them on the modules, being careful to match each one with the correct module.









## ***GE Fanuc Automation***

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***Programmable Control Products***



## ***GE Fanuc Automation***

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***P.O. Box 8106  
Charlottesville, VA 22906***

***GFZ-0085***

## ***Series 90<sup>TM</sup>-30 Programmable Controller***

***Troubleshooting Guide***



## ***GE Fanuc Automation***

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***Programmable Control Products***

### ***Series 90<sup>TM</sup>-30 Programmable Controller Troubleshooting Guide***

***GFZ-0085***

***August 1993***

## Notice

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| Series 90    | CIMPLICITY 90-ADS    | Genius      |
| Modelmaster  | Series Three         | VuMaster    |
| ProLoop      | CIMPLICITY PowerTRAC | Series Five |
| Workmaster   | Genius Power TRAC    |             |

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## Safety Considerations

### General Warnings When Troubleshooting

Stand clear of controlled equipment when power is applied. If the problem is intermittent, sudden unexpected machine motion could occur, causing injury. Also reference NFPA 70E Part II for additional guidelines for safety practices.

Never reach into a machine to operate a switch since unexpected motion could occur, causing injury.

Remove all electrical power at the Main Power Disconnect to ensure total power removal.

Always remove power before inserting or removing modules, or before connecting I/O cabling.

## Preface

This guide describes a logical sequence for troubleshooting your Series 90–30 programmable controller. It includes the procedure for changing or adding a EPROM or EEPROM to your CPU. The Series 90–30 PLC is a member of the Series 90<sup>TM</sup> family of programmable logic controllers from GE Fanuc Automation.

## Revisions to this Troubleshooting Guide

This is the first release of this Troubleshooting Guide. Included are models CPU 311, 313, 321, 323, 331 and 341.

## Related Publications

*Series 90<sup>TM</sup>–30 Programmable Controller Installation Manual* (GFK–0356).

*Series 90<sup>TM</sup>–30 and 90–20 PLC Hand–Held Programmer User's Manual* (GFK–0402)

*Logicmaster<sup>TM</sup> 90 Series 90–30 and 90–20 Programming Software User's Manual* (GFK–0466)

*Series 90<sup>TM</sup>–30/90–20 Programmable Controllers Reference Manual* (GFK–0467)

## We Welcome Your Comments and Suggestions

At GE Fanuc Automation, we strive to produce quality technical documentation. After you have used this troubleshooting guide, please take a few moments to write us with your comments and suggestions. Our address is: Manager Technical Publications, GE Fanuc Automation, PO Box 8106, Charlottesville, VA 22906

*Drake C. Fink*

Sr. Staff Systems Engineer

# SYMBOLS USED IN THIS GUIDE

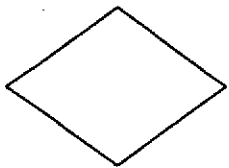


BEGIN AT THIS SYMBOL  
ON THE FIRST CHART.



FOLLOW THE PATH WITH  
THE CORRECT ANSWER IN  
THE DIRECTION OF THE  
ARROW

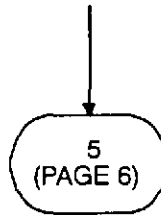
SYMBOLS USED THROUGHOUT THE GUIDE  
ARE GEOMETRICALLY CODED



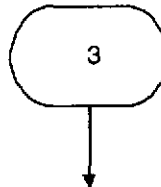
A DIAMOND ASKS A  
QUESTION



A RECTANGLE TELLS  
YOU TO DO SOMETHING



A NUMBERED BUBBLE WITH  
AN ARROW INTO THE BUBBLE  
INDICATES THAT THE  
PROCEDURE IS CONTINUED  
AT A CORRESPONDINGLY  
NUMBERED BUBBLE ON THE  
INDICATED PAGE NUMBER.



A NUMBERED BUBBLE WITH  
AN ARROW OUT OF THE  
BUBBLE INDICATES THE  
START OF A PROCEDURE ON  
THAT PAGE.

## Adding or Changing the EEPROM in the 90™—30

Application programs are normally developed in the CPU's RAM memory and executed from RAM memory. If additional program integrity is desired, or operation of the PLC without a battery is desired, an optional EEPROM or EPROM can be installed in a spare socket (labeled PROGRAM PROM) on the Model 311/313 backplane or in a socket on the model 331/341 CPU module. EEPROMs can be written to and read from. EPROMs can be read when installed in the PLC; however, they must be written to using an external PROM programming device.

Following is the procedure for adding or changing the EEPROM or EPROM. For clarity, the term PROM is used to refer to either an EEPROM or an EPROM.

1. Remove power from the system.
2. If 311/313
  - Remove all modules, including the power supply.
  - Remove the plastic cover.
3. If 331/341:
  - Remove CPU from backplane.
  - Remove front plate and bezel. Unsnap circuit board and remove from case.
4. If the socket is the type which has a screw near the top edge (some versions of 311/331), loosen screw at top of PROM socket (CCW twist;).
5. If present, remove old PROM from socket. Replace with or install new PROM. Orient the PROM so the end with a notch (the top of the prom) is toward the top edge of the backplane. Pin 1 of the prom is the first pin on the left as you move counter-clockwise from the notch. On the 311/331, correct installation orients the notch toward the screw.
6. When present, tighten screw at top of PROM socket (CW twist).
7. If 311/313:
  - Replace the plastic cover.
  - Replace all modules, including the power supply.

### 8. If 331 CPU:

- Assure jumper JP1, located at the bottom of the PROM socket, is in the 1–2 position for EPROM and the 3–2 position for EEPROM. This informs the CPU firmware which type of device is present.

### 9. If 331/341 CPU:

- Replace circuit board in case.
- Reinstall front plate and bezel.
- Replace CPU in backplane.

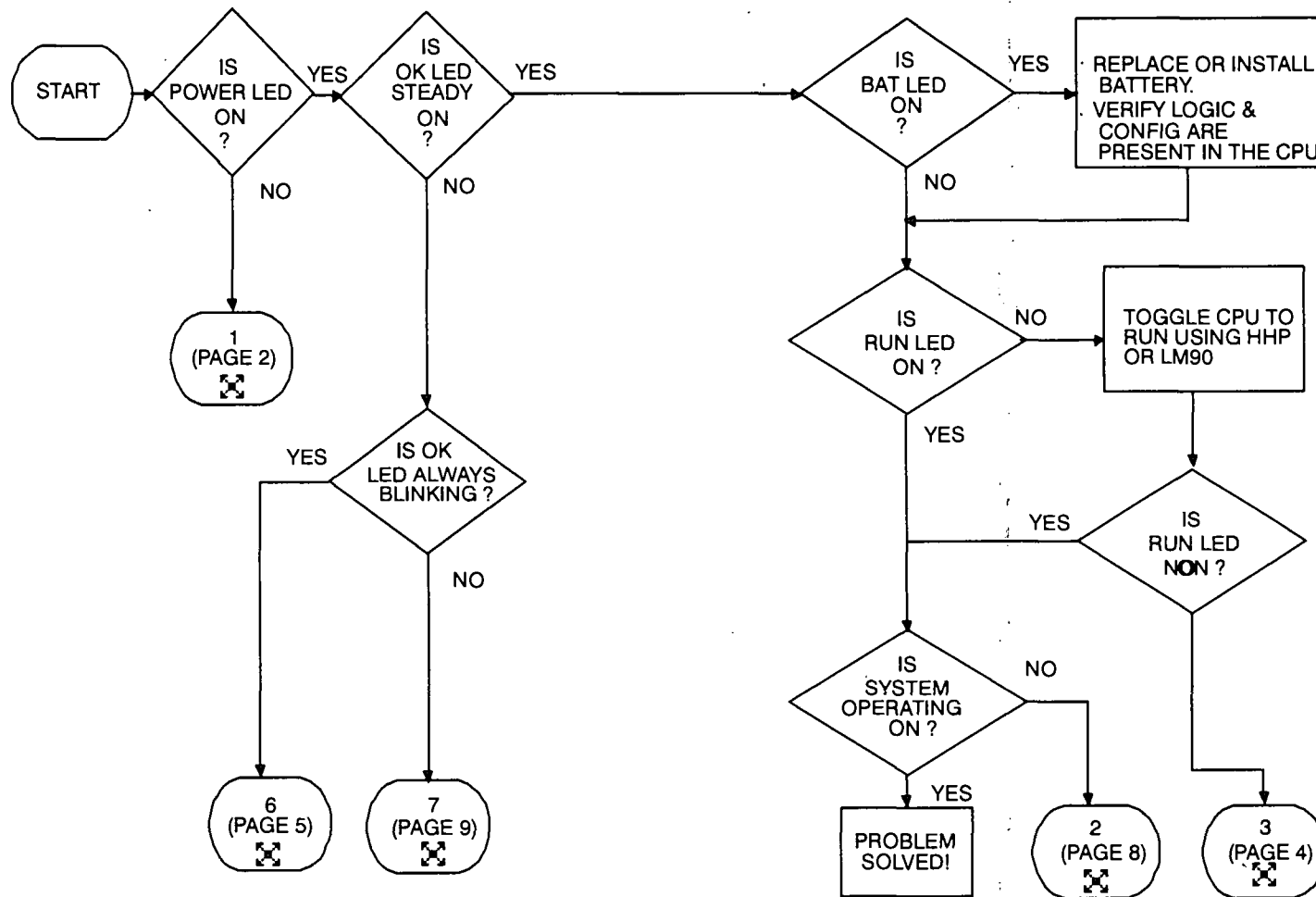
## Changing the EEPROM (continued)

10. Apply power. The PLC follows the flowchart found in the "Power-Up Sequence" figure in the Power-Up and Power-Down Section of the *Series 90-30/90-20 Programmable Controllers Reference Manual* (GFK-0467) to determine if a program will be loaded from PROM to RAM.
11. For the EEPROM to be used by the CPU, the CPU configuration must be set to use EEPROM as the "Program Source". You may use the LM90 Configuration software or the HHP to accomplish this.
12. To store the program in RAM, you may use either the Hand-Held Programmer or Logicmaster 90-30, Rev 3.5 or higher. Refer to the instructions in the *HHP User's Manual* (GFK-0402) for HHP. To use Logicmaster 90-30, follow these instructions:
  - Start the LM90-30 Programmer Package
  - Activate the Utilities Menu (F9)
  - Select the EEPROM function (F10)
  - Select the WRITE operation
  - Verify the items you want to write to EEPROM are selected.
  - Press ENTER to start the operation. Refer to the *Logicmaster 90 Series 90-30 and 90-20 Programming Software User's Manual* (GFK-0466) for more information.

## Notes and Precautions

1. **WARNING:** Do not discard the lithium–manganese dioxide battery in fire. Do not attempt to discharge the battery. The battery may burst or burn or release hazardous materials. Dispose of the battery as you would any hazardous material.
2. **CAUTION:** After a power fault, the system will come back on in the mode (*STOP, RUN/ENABLED, RUN/DISABLED*) in which it was operating before power loss, unless the power up configuration specifies a particular mode.
3. Not having a battery installed will not prevent the PLC from running. It will generate a PLC fault on power cycle that prevents the PLC from entering *RUN* mode automatically. Clearing this fault will enable the PLC to be placed in *RUN* mode.
4. To short the 'super cap' on a 311/321 PLC:
  - Remove power from the system.
  - Remove all modules, including the power supply.
  - Remove the plastic face plate.
  - Find component C20 along the left edge of the module. This is the 'super cap'. Short the positive (+) and negative (–) leads of this device.
  - Replace the plastic face plate.
  - Replace all modules.
  - Restore power to the system.
5. Supply (input) voltage tolerances for Series 90–30 power supplies:
 

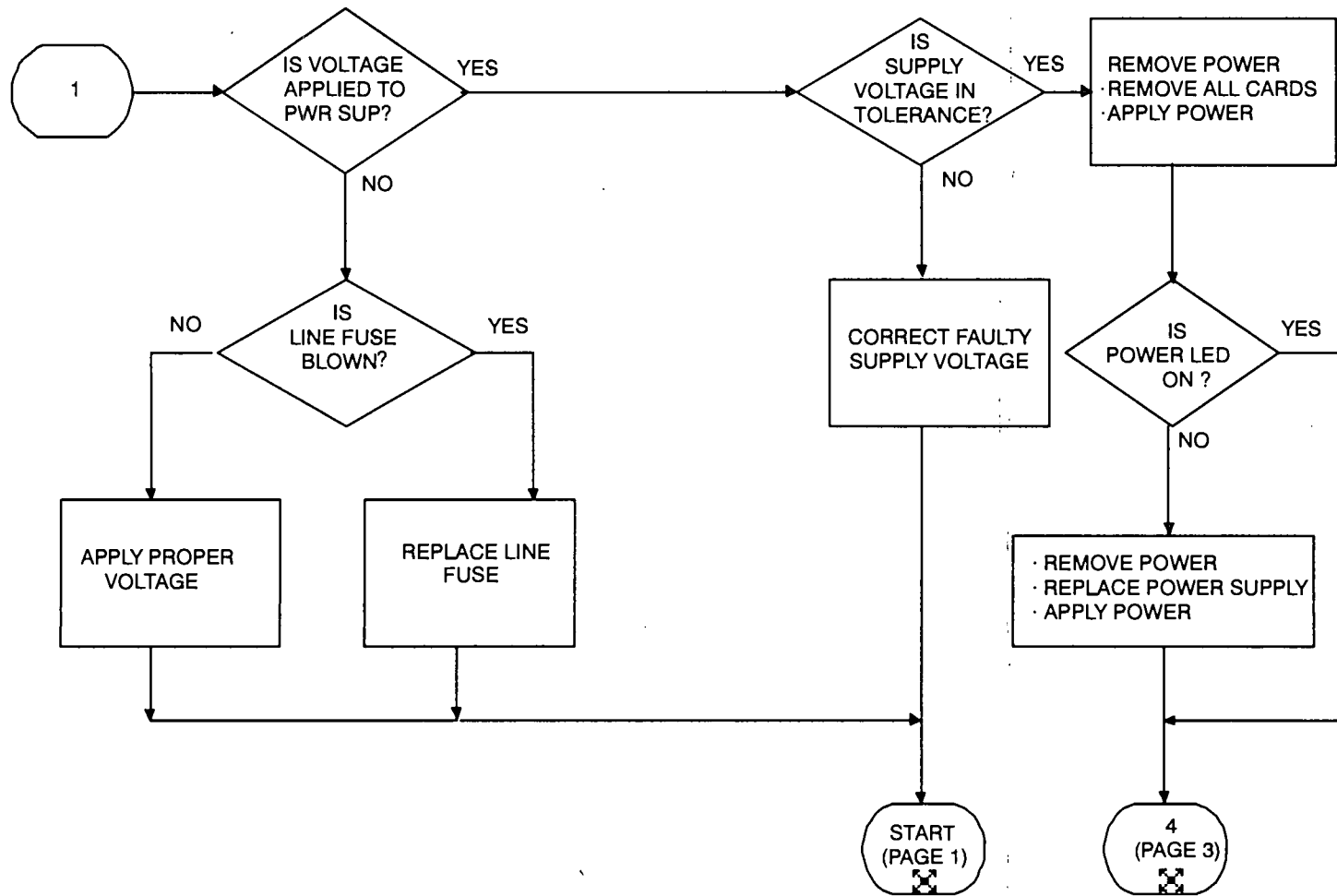
|              |  |
|--------------|--|
| IC693PWR321: | 100 to 240 VAC<br>100 to 250 VDC (125 VDC nominal)                   |
| IC693PWR322: | 18 to 56 VDC, 21 VDC<br>minimum to start<br>24 VDC OR 48 VDC nominal |
6. Total cable length must not exceed 50 feet between a CPU rack and an expansion rack. Length must not exceed 700 feet between a CPU rack and a remote rack. No termination plug is needed on a one–rack system.



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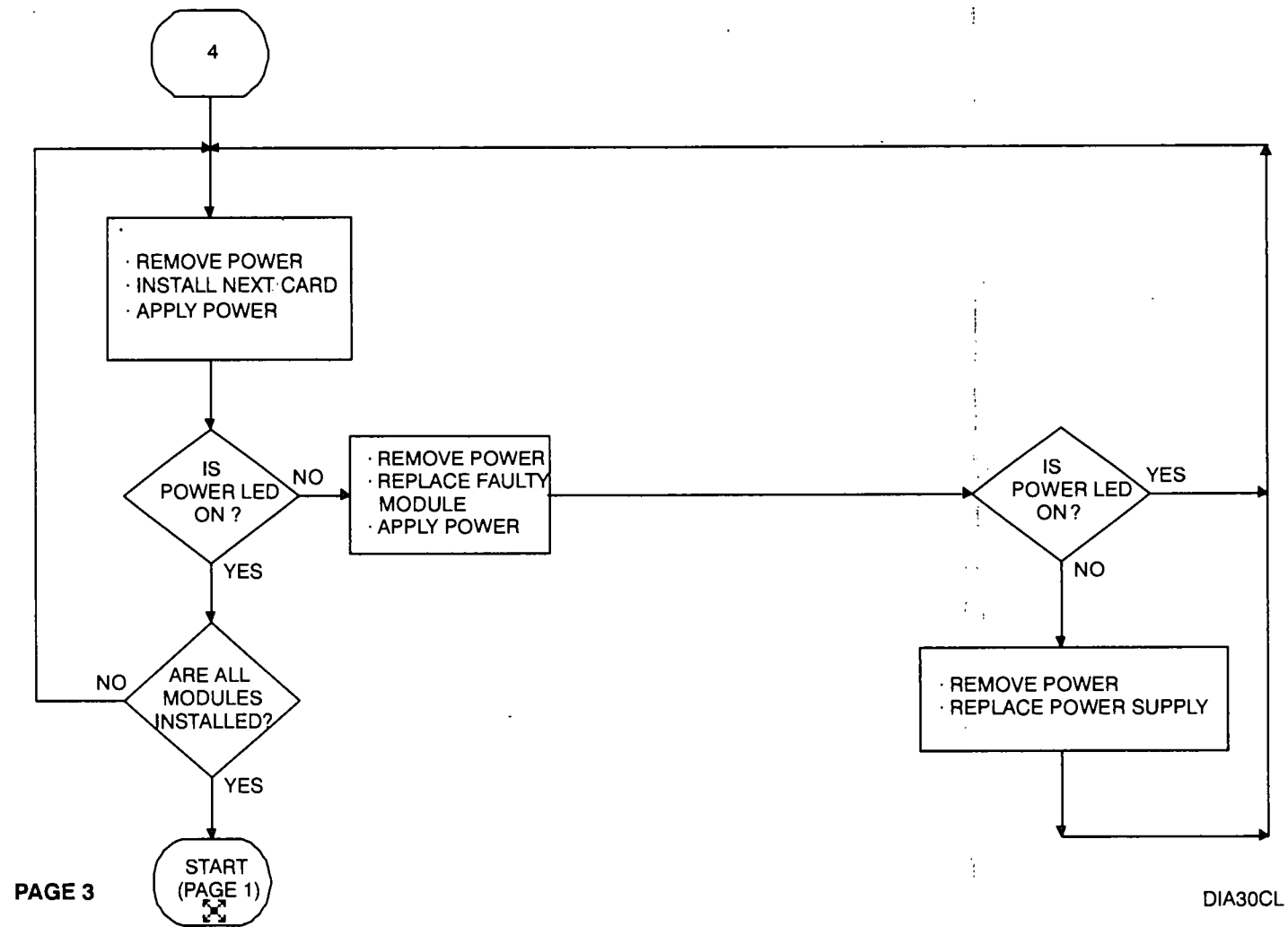
(Refer to the Preface for information on safety considerations, related publications and the symbols used in this guide.)

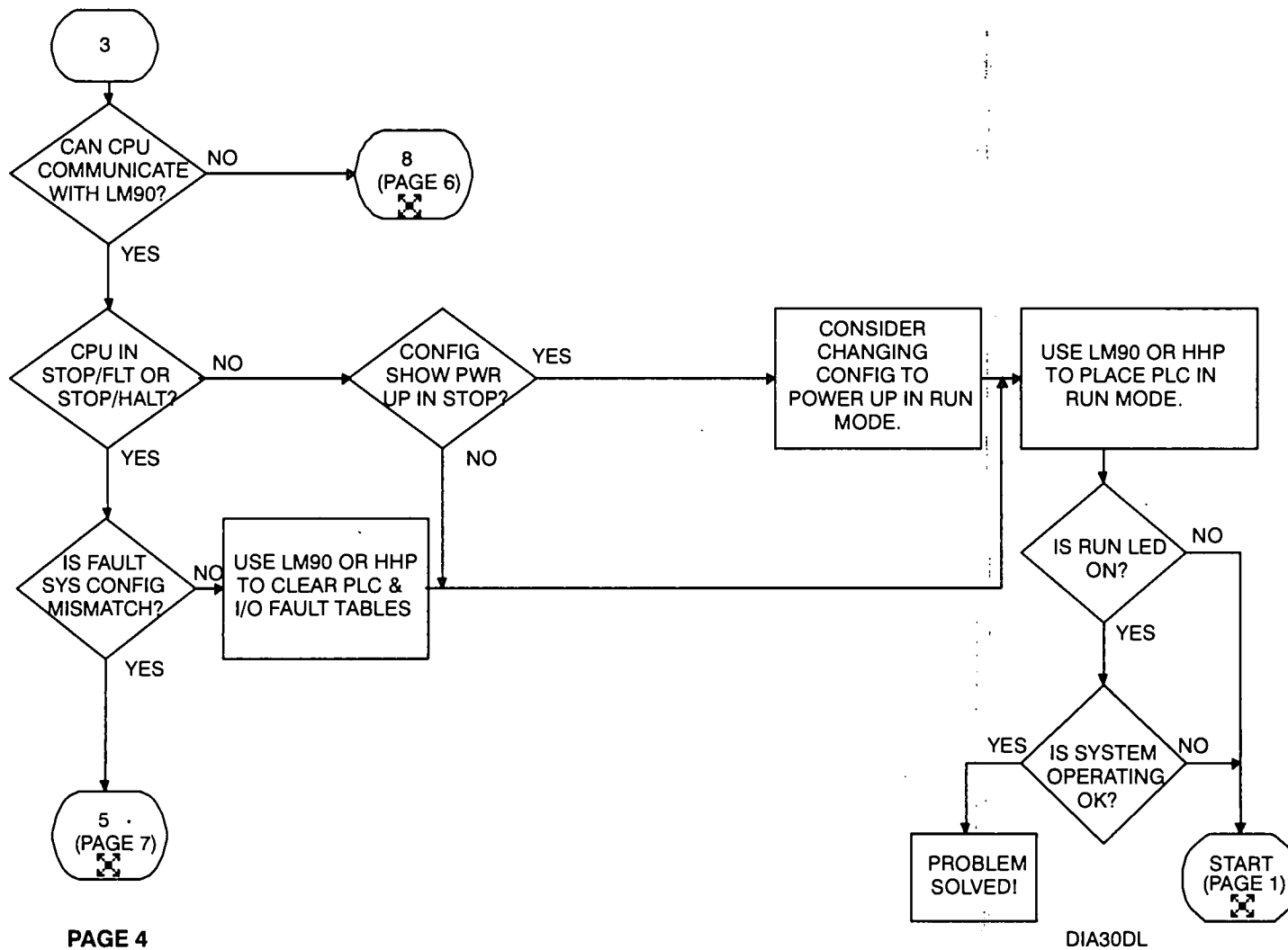
DIA30AL  
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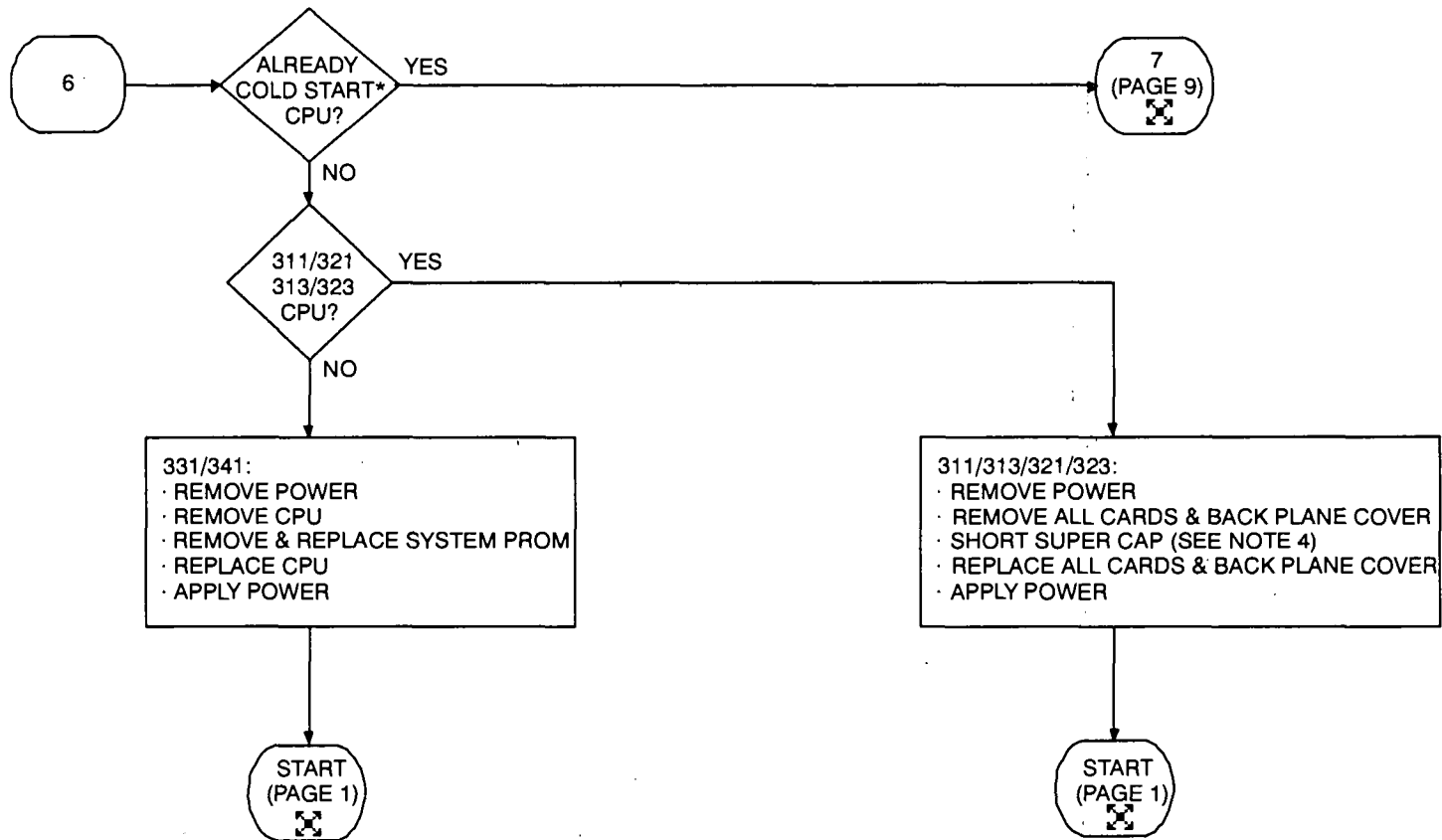


PAGE 2

DIA30BL



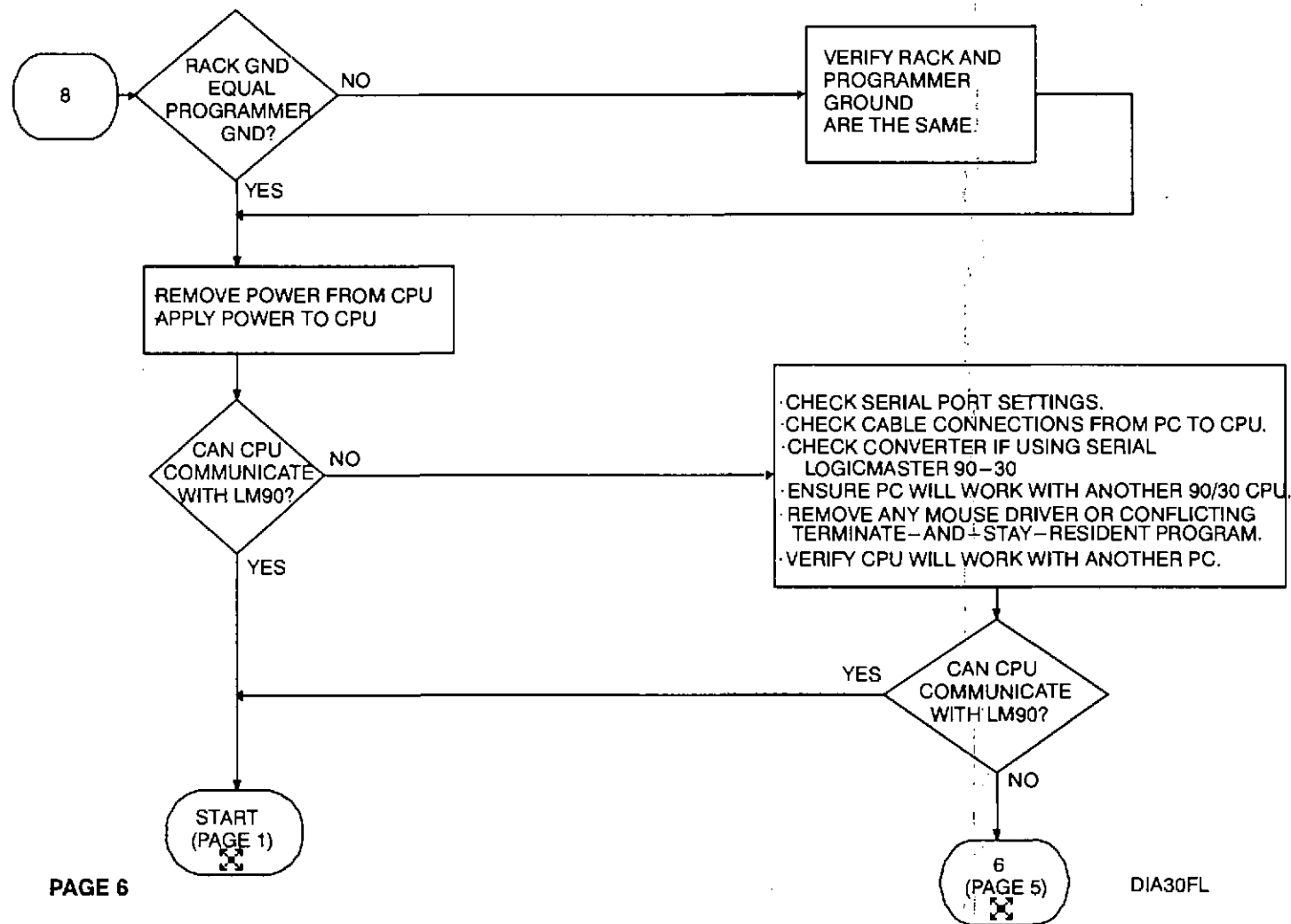


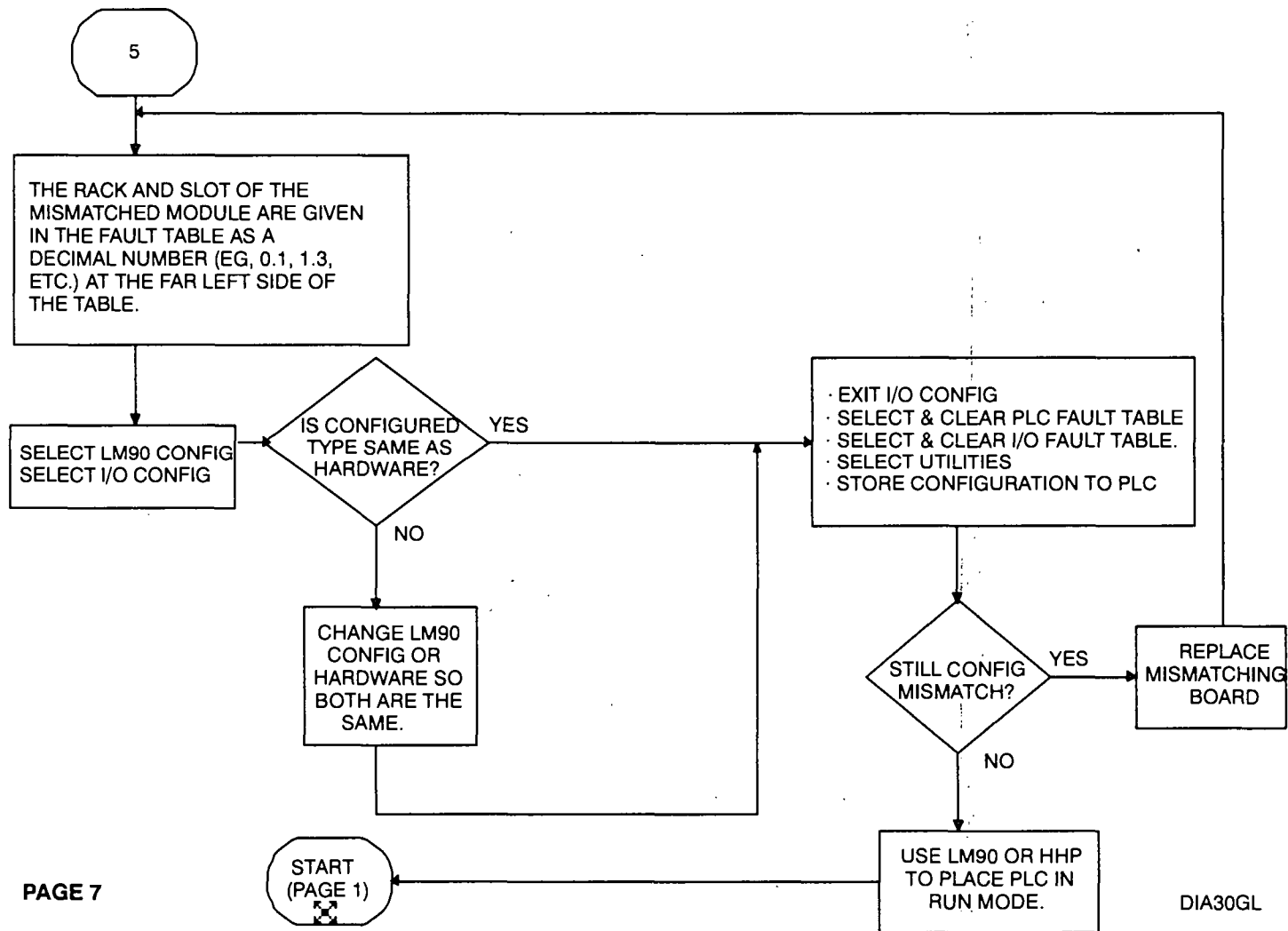


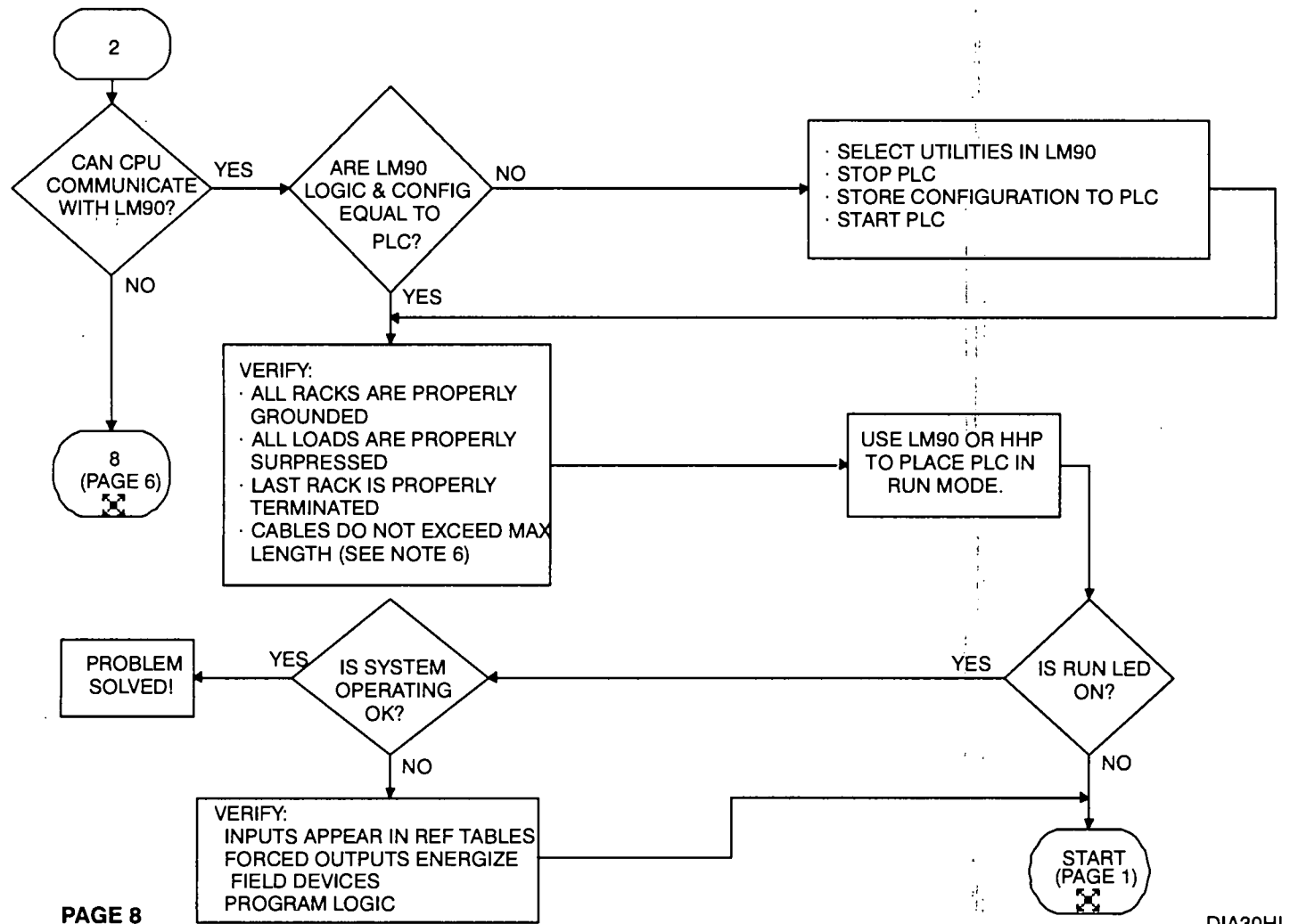
\*COLD START DELETES THE CONTENTS OF THE CPU'S MEMORY AND RESTORES COMMUNICATION PARAMETERS (BAUD RATE, PARITY, ETC.) TO THEIR DEFAULT VALUES.

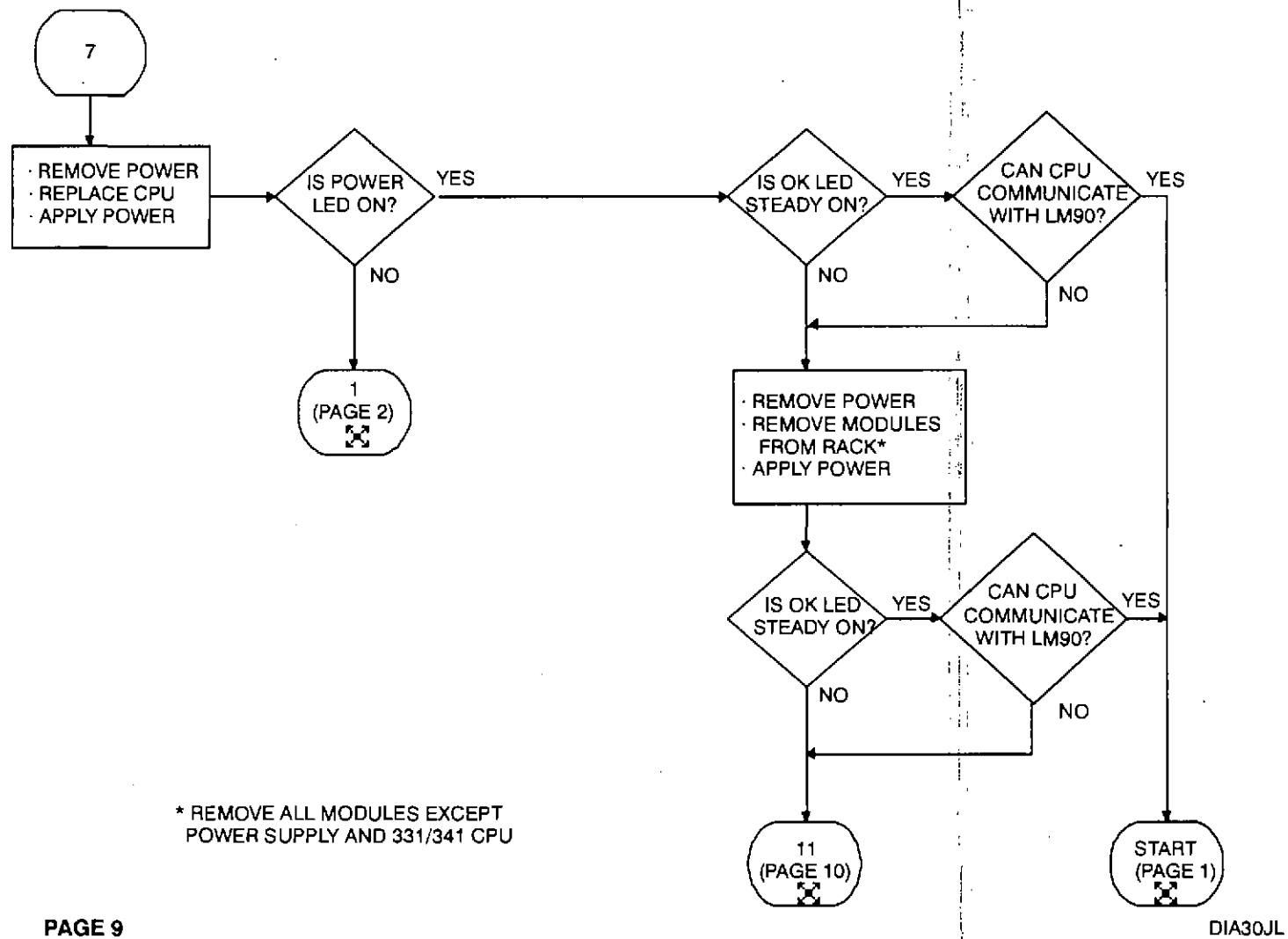
PAGE 5

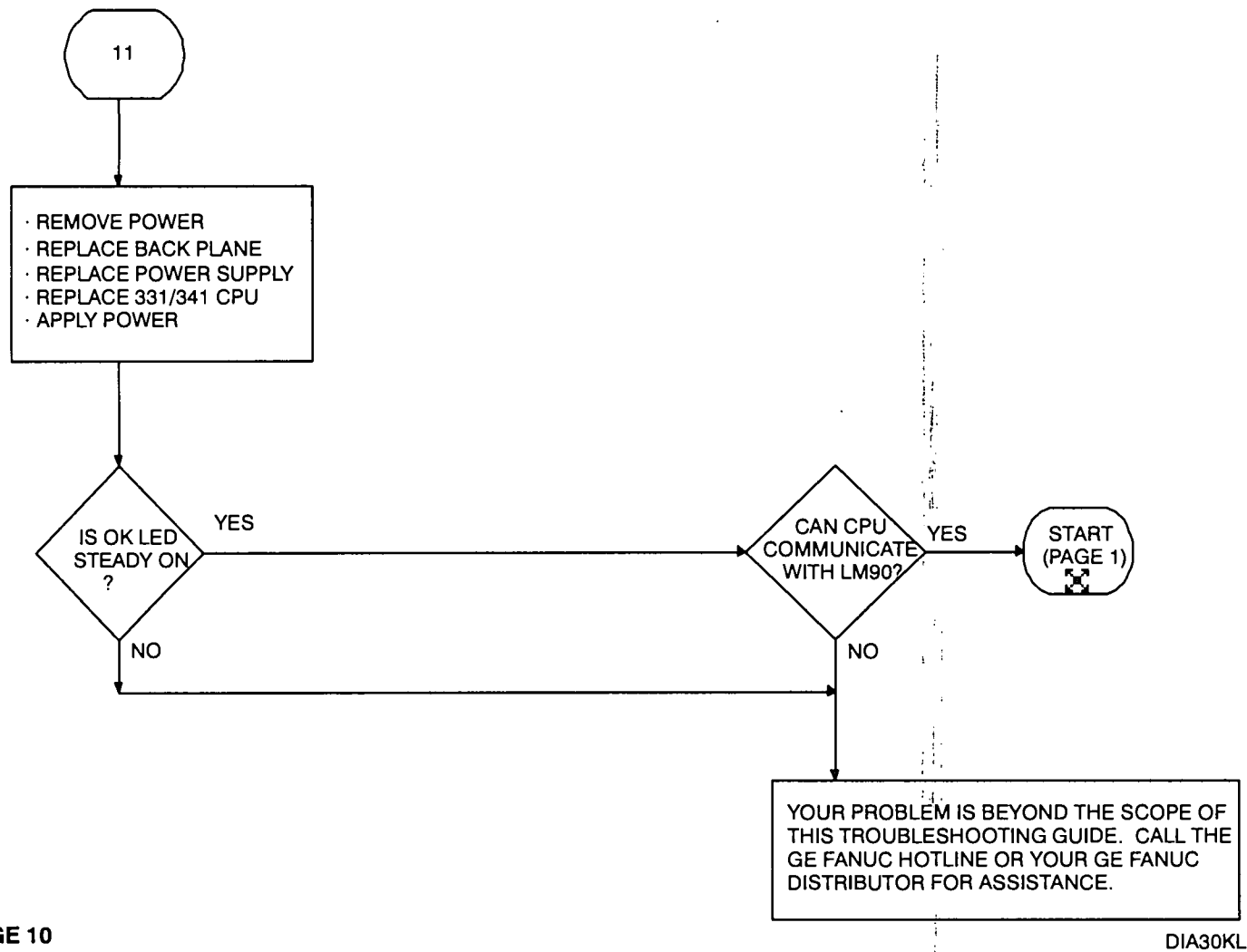
DIA30EL

















**DIESEL STANDBY GENERATOR**

**LOCAL CONTROL PANEL**

**FUNCTIONAL DESCRIPTION**

**FOR**

**Brisbane City Council**

19th May 2003

## ABBREVIATIONS

G1     Generator 1 Diesel

## 1. GENERAL

- 1.1. The PLC for the above operation is a GE Fanuc IC693CPU350. This program has been designed for the use on G1. The operation below controls G1.
- 1.2. A mode selector switch selects how G1 shall operate :
  - 1.2.1. Off
  - 1.2.2. Manual Mode
  - 1.2.3. Test Mode.
  - 1.2.4. Automatic Mode.

## 2. MANUAL MODE

- 2.1. To operate G1 in MANUAL Mode.
- 2.2. Select this operation by turning the AUTO – TEST – MAN- OFF selector switch to the MANUAL position.
- 2.3. Press the MANUAL START push button to start the generator.
- 2.4. The generator will begin to crank.
  - 2.4.1. If it fails to start within the 10 seconds, the starter motor is stopped and a delay of 10 seconds before it will attempt to restart.
  - 2.4.2. The generator set is allowed 3 attempts to start.
  - 2.4.3. If it fails to start on the third attempt, the generator is locked out on FAIL TO START Alarm.
  - 2.4.4. When the generator starts, the starter motor is stopped by a stop cranking input which measures the speed of the generator.
  - 2.4.5. Once the generator has started, there is a 10 second time delay for the oil pressure to stabilise.
  - 2.4.6. If the oil pressure is not up to pressure after the 10 second time delay, the generator shall shut down on LOW OIL PRESS Alarm.
  - 2.4.7. Once the generator is running there is a 5 second warm up time before it is ready to accept load.

- 2.5. To Manual Transfer to Generator in the MANUAL Mode.
  - 2.5.1. Start the generator and wait for the generator to run up to speed and voltage and ready to accept load.
  - 2.5.2. Press the MANUAL TRANSFER TO GEN push button.
  - 2.5.3. The MAINS ATS shall Open.
  - 2.5.4. After a 30 second delay the GEN ATS shall Close.
  - 2.5.5. If the MAINS ATS fails to Open.
    - 2.5.5.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.
    - 2.5.5.2. The system shall return back to MAINS ATS operation.
  - 2.5.6. If the GEN ATS fails to Close.
    - 2.5.6.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
    - 2.5.6.2. The system shall return back to MAINS ATS operation.
- 2.6. To Manual Transfer to Mains in the MANUAL Mode.
  - 2.6.1. The GENERATOR ATS is Closed.
  - 2.6.2. Press the MAN TRANSFER TO MAINS push button.
  - 2.6.3. The GEN ATS shall Open.
  - 2.6.4. After a 30 second delay the MAINS ATS shall Close.
  - 2.6.5. If the GEN ATS fails to Open.
    - 2.6.5.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
    - 2.6.5.2. The system shall return back to GEN ATS operation.
  - 2.6.6. If the MAINS ATS fails to Close.

2.6.6.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.

2.6.6.2. The system shall return back to GEN ATS operation.

2.7. To stop the generator in the MANUAL Mode.

2.7.1. When the generator is running, it may be stopped by pressing the MANUAL STOP push button.

2.7.2. If the generator is still GEN ATS operation. The MANUAL TRANSFER TO MAINS is initiated.

2.7.3. When the GEN ATS is Open, the generator will enter the cool down time of 1 second.

2.7.4. After the cool down time, the generator will shut down.

2.7.5. Once the generator has shut down there is a 15 second delay before it may be restarted. This is to ensure the engine has mechanically stopped.

### 3. **NON-PERMANENT SITE, MANUAL MODE**

- 3.1. To operate G1 in a Non-Permanent Site Location in MANUAL Mode.
- 3.2. Connect the generator cables to the site generator CB ensuring the site generator CB is OFF. See BCC procedures.
- 3.3. A plug with shorting links is required to be installed. It is required to be plugged into the 27 Pin Station Plug.
  - 3.3.1. Pins 11 and 12 are required to be connected. This is to indicate that the Mains ATS is Closed. If they are not connected a MAINS ATS Alarm shall be indicated.
- 3.4. Select from the AUTO – TEST – MAN- OFF selector switch to the MANUAL position.
- 3.5. Press the MANUAL START push button to start the generator.
- 3.6. The generator will begin to crank.
  - 3.6.1. If it fails to start within the 10 seconds, the starter motor is stopped and a delay of 10 seconds before it will attempt to restart.
  - 3.6.2. The generator set is allowed 3 attempts to start.
  - 3.6.3. If it fails to start on the third attempt, the generator is locked out on FAIL TO START Alarm.
  - 3.6.4. When the generator starts, the starter motor is stopped by a stop cranking input which measures the speed of the generator.
  - 3.6.5. Once the generator has started, there is a 10 second time delay for the oil pressure to stabilise.
  - 3.6.6. If the oil pressure is not up to pressure after the 10 second time delay, the generator shall shut down on LOW OIL PRESS Alarm.
  - 3.6.7. Once the generator is running there is a 5 second warm up time before it is ready to accept load.
- 3.7. To connect the generator to the site load.
  - 3.7.1. Manually switch over to the generator supply via the site CB's. See BCC procedures.
  - 3.7.2. Do not use the MANUAL TRANSFER TO GEN or the MAN TRANSFER TO MAINS push buttons.

- 3.8. To disconnect the generator from the site load.
  - 3.8.1. Manually switch over to the mains supply via the site CB's. See BCC procedures.
  - 3.8.2. Do not use the MANUAL TRANSFER TO GEN or the MAN TRANSFER TO MAINS push buttons.
- 3.9. To stop the generator in the MANUAL Mode.
  - 3.9.1. When the generator is running, it may be stopped by pressing the MANUAL STOP push button.
  - 3.9.2. The generator will enter the cool down time of 1 second.
  - 3.9.3. After the cool down time, the generator will shut down.
  - 3.9.4. Once the generator has shut down there is a 15 second delay before it may be restarted. This is to ensure the engine has mechanically stopped.

#### 4. **TEST OPERATION**

- 4.1. To operate the generator in the TEST Mode.
- 4.2. Select this operation by turning the AUTO – TEST – MAN- OFF selector switch to the TEST position.
- 4.3. If the selector is changed to MAN while the generator is operating on TEST, the system shall change to MANUAL TRANSFER TO GEN.
- 4.4. The generator shall begin to crank.
  - 4.4.1. If it fails to start within the 10 seconds, the starter motor is stopped and a delay of 10 seconds before it will attempt to restart.
  - 4.4.2. The generator is allowed 3 attempts to start.
  - 4.4.3. If it fails to start on the third attempt, the generator is faulted on FAIL TO START Alarm.
- 4.5. When the generator starts, the starter motor is stopped by a stop cranking input which measures the speed of the generator.
- 4.6. The MAINS ATS shall Open.
- 4.7. Once the generator has started, there is a 10 second time delay for the oil pressure to stabilise.
- 4.8. If the oil pressure is not up to pressure after the 10 second time delay, the generator shall shut down on LOW OIL PRESS Alarm.
- 4.9. Once the generator is running there is a 5 second warm up time before it is ready to accept load.
- 4.10. After the warm up time has expired and the MAINS ATS has been open for 30 seconds the GEN ATS shall Close.
- 4.11. If the MAINS ATS fails to Open.
  - 4.11.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.
  - 4.11.2. The system shall shut down and return back to MAINS ATS operation.
- 4.12. If the GEN ATS fails to Close.

- 4.12.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
- 4.12.2. The system shall shut down and return back to MAINS ATS operation.
- 4.13. To stop the generator in the TEST Mode.
  - 4.13.1. Select this operation by turning the AUTO – TEST – MAN- OFF selector switch to the AUTO or OFF position.
  - 4.13.2. The GEN ATS shall Open.
  - 4.13.3. After a 30 second delay the MAINS ATS shall Close.
  - 4.13.4. If the GEN ATS fails to Open.
    - 4.13.4.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
    - 4.13.4.2. The system shall return back to GEN ATS operation.
  - 4.13.5. If the MAINS ATS fails to Close.
    - 4.13.5.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.
    - 4.13.5.2. The system shall return back to GEN ATS operation.
  - 4.13.6. When the GEN ATS is Open, the generator will enter the cool down time of 5 minutes.
  - 4.13.7. After the cool down time, the generator will shut down.
  - 4.13.8. If a Mains Failure occurs during the cool down period the generator shall transfer back to the GENERATOR ATS without shutting down.
  - 4.13.9. Once the generator has shut down there is a 15 second delay before it may be restarted. This is to ensure the engine has mechanically stopped.

## 5. AUTOMATIC OPERATION

- 5.1. To operate the generator in the AUTO Mode.
- 5.2. Select this operation by turning the AUTO – TEST – MAN- OFF selector switch to the AUTO position.
- 5.3. The Phase Failure Relay from the clients switch board shall give a Start Signal for the generators to run.
- 5.4. The Remote Start Command.
  - 5.4.1. The generator shall begin to crank.
    - 5.4.1.1. If it fails to start within the 10 seconds, the starter motor is stopped and a delay of 10 seconds before it will attempt to restart.
    - 5.4.1.2. The generator is allowed 3 attempts to start.
    - 5.4.1.3. If it fails to start on the third attempt, the generator is faulted on FAIL TO START Alarm.
  - 5.4.2. When the generator starts, the starter motor is stopped by a stop cranking input which measures the speed of the generator.
  - 5.4.3. The MAINS ATS shall Open.
  - 5.4.4. Once the generator has started, there is a 10 second time delay for the oil pressure to stabilise.
  - 5.4.5. If the oil pressure is not up to pressure after the 10 second time delay, the generator shall shut down on LOW OIL PRESS Alarm.
  - 5.4.6. Once the generator is running there is a 5 second warm up time before it is ready to accept load.
  - 5.4.7. After the warm up time has expired and the MAINS ATS has been open for 30 seconds the GEN ATS shall Close.
  - 5.4.8. If the MAINS ATS fails to Open.
    - 5.4.8.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.

- 5.4.8.2. The system shall shut down and return back to MAINS ATS operation.
- 5.4.9. If the GEN ATS fails to Close.
  - 5.4.9.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
  - 5.4.9.2. The system shall shut down and return back to MAINS ATS operation.
- 5.5. To stop the generator in the AUTO Mode.
  - 5.5.1. The Phase Failure Relay from the clients switch board shall give a Stop Signal for the generators to run.
  - 5.5.2. The Remote Stop Command.
  - 5.5.3. There is a 2 minute proving time for the Phase Failure Relay.
  - 5.5.4. After the 2 minute proving time the GEN ATS shall Open.
  - 5.5.5. After a 30 second delay the MAINS ATS shall Close.
  - 5.5.6. If the GEN ATS fails to Open.
    - 5.5.6.1. After a 5 second delay an Alarm shall be generated and the GENERATOR CONNECTED indicator shall flash to indicate the Alarm.
    - 5.5.6.2. The system shall return back to GEN ATS operation.
  - 5.5.7. If the MAINS ATS fails to Close.
    - 5.5.7.1. After a 5 second delay an Alarm shall be generated and the MAINS CONNECTED indicator shall flash to indicate the Alarm.
    - 5.5.7.2. The system shall return back to GEN ATS operation.
  - 5.5.8. When the GEN ATS is Open, the generator will enter the cool down time of 5 minutes.
  - 5.5.9. After the cool down time, the generator will shut down.
  - 5.5.10. If a Mains Failure occurs during the cool down period the generator shall transfer back to the GENERATOR ATS without shutting down.

5.5.11. Once the generator has shut down there is a 15 second delay before it may be restarted. This is to ensure the engine has mechanically stopped.

## 6. FAULT OPERATION

### 6.1. Emergency Stop Operation.

- 6.1.1. Operation of the Emergency Stop push button immediately shuts down the generator and Opens the Generator CB. The Emergency Stop is latched, and requires manual resetting to release the Emergency Stop push button.
- 6.1.2. After the Emergency Stop push button is released, a fault reset will need to be initiated to reset the PLC.

### 6.2. HIGH HIGH Alarm Operation.

- 6.2.1. The Generator CB is Opened immediately.
- 6.2.2. The generator is shut down immediately.
- 6.2.3. The following alarms will initiate a HIGH HIGH Alarm condition :-
  - 6.2.3.1. Emergency Stop Fault
  - 6.2.3.2. MEN Fault
  - 6.2.3.3. Low Oil Pressure Shutdown Fault, 10 Seconds Startup Delay
  - 6.2.3.4. High Engine Temperature Shutdown Fault, 30 Second Startup Delay
  - 6.2.3.5. Low Radiator Level Fault, 5 Second Delay
  - 6.2.3.6. Over Speed Fault

### 6.3. HIGH Alarm Operation

- 6.3.1. The Generator CB is Opened immediately.
- 6.3.2. Once the generator circuit breaker is opened, the generator will run through its normal cool down time and shut down.
- 6.3.3. The following alarms will initiate a HIGH Alarm condition:-
  - 6.3.3.1. Generator Under Speed Fault, 5 Second Delay
  - 6.3.3.2. Alternator Under Voltage Fault, 5 Second Delay
  - 6.3.3.3. Alternator Over Voltage Fault, 5 Second Delay

6.3.3.4. Generator CB Tripped Fault

6.3.3.5. Alternator High Temperature Fault, 30 Second Startup Delay

6.4. MEDIUM Alarm Operation.

6.4.1. A Normal Shutdown shall be Initiated.

6.4.2. If the GEN ATS does not Open then the Generator CB is Opened.

6.4.3. The following alarms will initiate a MEDIUM Alarm condition :-

6.4.3.1. Fuel Empty Level Fault, 5 Second Delay

6.4.3.2. Fail To Start Fault, 3 Attempts

6.5. LOW Alarm Operation.

6.5.1. A Warning has occurred on the generator. The generator will not shut down.

6.5.2. The following alarms will initiate a LOW Alarm condition :-

6.5.2.1. Low Oil Pressure Warning Alarm, 10 Seconds Startup Delay

6.5.2.2. High Engine Temperature Warning Alarm, 30 Second Startup Delay

6.5.2.3. Fuel Low Level Alarm, 5 Second Delay

6.5.2.4. Battery Charger AC Supply Failed Alarm, 60 Second Delay

6.5.2.5. Control Battery Low Volts Alarm, 30 Second Delay

6.5.2.6. Start Battery Low Volts Alarm, 60 Second Delay





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| Power Consumption   | 4 |
| IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic | 4 |
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| Power Consumption   | 4 |
| IC693MDL940 16 Circuit Output Relay 2A                        | 4 |
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| Wiring  | 5 |
| Power Consumption   | 5 |
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Main Rack: Base 10 Slot (IC693CHS391)

Overview

GE Fanuc Hardware Configuration

Series 90-30

11/06/04 3:02BCC 4000 4Page: 2**Main Rack: Slot 0****IC693PWR331 Power Supply 24 VDC 30W****Power Consumption****Voltages / Supplied**

+5VDC (Watts) 30  
 +24VDC Relay Power (Watts) 15  
 +24VDC Isolated (Watts) 20  
 Total System: 30

**Settings****Parameters / Values**

Hand Held Programmer: No  
 Converter: 0

**Main Rack: Slot 1****IC693CPU350 Series 90-30 CPU Model 350****Settings****Parameters / Values**

I/O Scan-Stop: No  
 Power Up Mode: Run  
 Logic / Configuration From: RAM  
 Registers: RAM  
 Passwords: Disabled  
 Checksum Words: 8  
 Data Rate (bps): 19200  
 Parity: Odd  
 Stop Bits: 1  
 Modem Turnaround Time (.01 Sec / Count): 0  
 Idle Time (Sec): 10  
 Timer Faults: Disabled  
 SNP ID:  
 Key Switch Run/Stop: Enabled  
 Memory Protect: Disabled  
 Ignore Fatal Faults: Disabled

**Scan****Parameters / Values**

Sweep Mode: Normal  
 Sweep Timer (mSec): N/A

**Memory****Parameters / Values**

%I Discrete Input: 2048  
 %Q Discrete Output: 2048  
 %S System Use: 128  
 %M Internal Discrete: 4096  
 %T Temporary Status: 256  
 %G Genius® Global: 1280  
 %AI Analog Input: 2048  
 %AQ Analog Output: 512  
 %R Register Memory: 9999

Detailed ViewGE Fanuc Hardware ConfigurationSeries 90-30

11/06/04 3:02BCC 4000 4Page: 3**Power Consumption****Parameters / Values**

+5VDC (Watts) 3.35  
+24VDC Relay Power (Watts) 0  
+24VDC Isolated (Watts) 0

**Main Rack: Slot 2****IC693CMM311 Communications Coprocessor****Settings****Parameters / Values**

Configuration Mode: RTU Only

**Port 1****Parameters / Values**

RTU Enable: Yes  
Data Rate (bps): 9600  
Flow Control: None  
Parity: None  
Station Address: 1

**Port 2****Parameters / Values**

RTU Enable: Yes  
Interface: RS485  
Data Rate (bps): 9600  
Flow Control: None  
Parity: None  
Station Address: 1

**Power Consumption****Parameters / Values**

+5VDC (Watts) 2.00  
+24VDC Relay Power (Watts) 0  
+24VDC Isolated (Watts) 0

**Main Rack: Slot 3****IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic****Settings****Parameters / Values**

Reference Address: %I00001  
Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.40  
+24VDC Relay Power (Watts) 0

Detailed ViewGE Fanuc Hardware ConfigurationSeries 90-30

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+24VDC Isolated (Watts) 0.6

**Main Rack: Slot 4****IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic Settings****Parameters / Values**

Reference Address: %I00017

Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.40

+24VDC Relay Power (Watts) 0

+24VDC Isolated (Watts) 0.6

**Main Rack: Slot 5****IC693MDL645 16 Circuit Input 24 VDC Positive / Negative Logic Settings****Parameters / Values**

Reference Address: %I00033

Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.40

+24VDC Relay Power (Watts) 0

+24VDC Isolated (Watts) 0.6

**Main Rack: Slot 7****IC693MDL940 16 Circuit Output Relay 2A****Settings****Parameters / Values**

Reference Address: %Q00001

Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption**Detailed ViewGE Fanuc Hardware ConfigurationSeries 90-30

11/06/04 3:02BCC 4000 4Page: 5**Parameters / Values**

+5VDC (Watts) 0.04  
+24VDC Relay Power (Watts) 3.24  
+24VDC Isolated (Watts) 0

**Main Rack: Slot 8****IC693MDL940 16 Circuit Output Relay 2A****Settings****Parameters / Values**

Reference Address: %Q00017  
Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.04  
+24VDC Relay Power (Watts) 3.24  
+24VDC Isolated (Watts) 0

**Main Rack: Slot 9****IC693MDL940 16 Circuit Output Relay 2A****Settings****Parameters / Values**

Reference Address: %Q00033  
Length: 16

**Wiring****Terminal / Wiring Information**

From Terminal 1 to Terminal 20 : No wiring information.

**Power Consumption****Parameters / Values**

+5VDC (Watts) 0.04  
+24VDC Relay Power (Watts) 3.24  
+24VDC Isolated (Watts) 0

Detailed ViewGE Fanuc Hardware ConfigurationSeries 90

11/06/04 3:02BCC\_4000\_4Page: 6**%I References**

| <b>Overlap</b> | <b>Start</b> | <b>End</b> | <b>Addr</b> | <b>Mem Type</b> | <b>Cat Num</b> |
|----------------|--------------|------------|-------------|-----------------|----------------|
|                | 1            | 16         | (0.3)       | Consumed        | IC693MDL645    |
|                | 17           | 32         | (0.4)       | Consumed        | IC693MDL645    |
|                | 33           | 48         | (0.5)       | Consumed        | IC693MDL645    |

Total %I: 48                      Highest Reference: 48

**%Q References**

| <b>Overlap</b> | <b>Start</b> | <b>End</b> | <b>Addr</b> | <b>Mem Type</b> | <b>Cat Num</b> |
|----------------|--------------|------------|-------------|-----------------|----------------|
|                | 1            | 16         | (0.7)       | Produced        | IC693MDL940    |
|                | 17           | 32         | (0.8)       | Produced        | IC693MDL940    |
|                | 33           | 48         | (0.9)       | Produced        | IC693MDL940    |

Total %Q: 48                      Highest Reference: 48

Reference DetailsGE Fanuc Hardware ConfigurationSeries 90-30

| Name             | Type | Len | Address | Description                         | Stored Val | Scope  | Ret | Ovr | E |
|------------------|------|-----|---------|-------------------------------------|------------|--------|-----|-----|---|
| SEL_AUTO         | BIT  | 1   | %I00001 | Selector Switch Auto                |            | Global | R   |     |   |
| SEL_TEST         | BIT  | 1   | %I00002 | Selector Switch Test                |            | Global | R   |     |   |
| SEL_MAN          | BIT  | 1   | %I00003 | Selector Switch Manual              |            | Global | R   |     |   |
| EM_STOP_PB       | BIT  | 1   | %I00004 | Emergency Stop PB                   |            | Global | R   |     |   |
| LAMP_TEST_PB     | BIT  | 1   | %I00005 | Lamp Test PB                        |            | Global | R   |     |   |
| ALM_RESET_PB     | BIT  | 1   | %I00006 | Alarm Reset PB                      |            | Global | R   |     |   |
| ALM_MUTE_PB      | BIT  | 1   | %I00007 | Alarm Mute PB                       |            | Global | R   |     |   |
| MAN_STR_PB       | BIT  | 1   | %I00008 | Manual Start PB                     |            | Global | R   |     |   |
| MAN_STP_PB       | BIT  | 1   | %I00009 | Manual Stop PB                      |            | Global | R   |     |   |
| MAN_TRF_MAINS_PB | BIT  | 1   | %I00010 | Manual Transfer to Mains PB         |            | Global | R   |     |   |
| MAN_TRF_GEN_PB   | BIT  | 1   | %I00011 | Manual Transfer to Generator PB     |            | Global | R   |     |   |
| SPD_STP_CRK      | BIT  | 1   | %I00017 | Crank Cutout Relay                  |            | Global | R   |     |   |
| SPD_UNDER        | BIT  | 1   | %I00018 | Under Speed Relay                   |            | Global | R   |     |   |
| SPD_OVER         | BIT  | 1   | %I00019 | Over Speed Relay                    |            | Global | R   |     |   |
| VOLTS_UNDER      | BIT  | 1   | %I00020 | Under Voltage Relay                 |            | Global | R   |     |   |
| VOLTS_OVER       | BIT  | 1   | %I00021 | Over Voltage Relay                  |            | Global | R   |     |   |
| ALT_TEMP         | BIT  | 1   | %I00022 | Alternator High Temperature Relay   |            | Global | R   |     |   |
| GEN_CB_TRIP      | BIT  | 1   | %I00023 | Generator CB Tripped                |            | Global | R   |     |   |
| MEN_FLT          | BIT  | 1   | %I00024 | MEN Fault Relay                     |            | Global | R   |     |   |
| BAT_CHG_AC       | BIT  | 1   | %I00025 | Battery Charger AC Relay            |            | Global | R   |     |   |
| BAT_CONT_LOW_V   | BIT  | 1   | %I00026 | Control Battery Charger Low Voltage |            | Global | R   |     |   |
| BAT_STR_LOW_V    | BIT  | 1   | %I00027 | Start Battery Charger Low Voltage   |            | Global | R   |     |   |
| MAINS_FAILED     | BIT  | 1   | %I00033 | BCC Mains Failed                    |            | Global | R   |     |   |
| MAINS_ATS_CLS    | BIT  | 1   | %I00034 | BCC Mains ATS Closed                |            | Global | R   |     |   |
| GEN_ATS_CLS      | BIT  | 1   | %I00035 | BCC Generator ATS Closed            |            | Global | R   |     |   |
| REM_STR          | BIT  | 1   | %I00036 | BCC Remote Start                    |            | Global | R   |     |   |
| REM_STP          | BIT  | 1   | %I00037 | BCC Remote Stop                     |            | Global | R   |     |   |
| OIL_P_LOW_SD     | BIT  | 1   | %I00041 | Low Oil Pressure Shutdown           |            | Global | R   |     |   |
| OIL_P_LOW_W      | BIT  | 1   | %I00042 | Low Oil Pressure Warning            |            | Global | R   |     |   |
| ENG_T_HI_SD      | BIT  | 1   | %I00043 | High Engine Temperature Shutdown    |            | Global | R   |     |   |
| ENG_T_HI_W       | BIT  | 1   | %I00044 | High Engine Temperature Warning     |            | Global | R   |     |   |
| RAD_WATER_LOW    | BIT  | 1   | %I00045 | Low Radiator Water Level            |            | Global | R   |     |   |
| FUEL_LEV_LOW     | BIT  | 1   | %I00046 | Low Fuel Level                      |            | Global | R   |     |   |
| FUEL_LEV_EMPTY   | BIT  | 1   | %I00047 | Fuel Empty                          |            | Global | R   |     |   |
| CAN_DOORS_OPEN   | BIT  | 1   | %I00048 | Canopy Doors Open                   |            | Global | R   |     |   |
| STEP_1           | BIT  | 1   | %M00001 | Step Sequence No.1                  |            | Global |     |     |   |
| STEP_2_E         | BIT  | 1   | %M00002 | Step Sequence No.2                  |            | Global |     |     |   |
| STEP_3           | BIT  | 1   | %M00003 | Step Sequence No.3                  |            | Global |     |     |   |
| STEP_4           | BIT  | 1   | %M00004 | Step Sequence No.4                  |            | Global |     |     |   |
| STEP_5           | BIT  | 1   | %M00005 | Step Sequence No.5                  |            | Global |     |     |   |
| STEP_6           | BIT  | 1   | %M00006 | Step Sequence No.6                  |            | Global |     |     |   |
| STEP_7           | BIT  | 1   | %M00007 | Step Sequence No.7                  |            | Global |     |     |   |
| STEP_8           | BIT  | 1   | %M00008 | Step Sequence No.8                  |            | Global |     |     |   |
| STEP_9           | BIT  | 1   | %M00009 | Step Sequence No.9                  |            | Global |     |     |   |
| STEP_2_GE        | BIT  | 1   | %M00022 | Step Sequence No.2 GE               |            | Global |     |     |   |
| GEN_OFF          | BIT  | 1   | %M00101 | Generator OFF                       |            | Global |     |     |   |
| AUTO_TEST_STR    | BIT  | 1   | %M00102 | Auto Test Start / Stop              |            | Global |     |     |   |
| REMOTE_STR       | BIT  | 1   | %M00103 | Remote Start                        |            | Global |     |     |   |
| MAINS_FAIL_STP   | BIT  | 1   | %M00104 | Mains Failed Stop                   |            | Global |     |     |   |
| REMOTE_STP       | BIT  | 1   | %M00105 | Remote Stop                         |            | Global |     |     |   |
| TEST_STR         | BIT  | 1   | %M00106 | Test Start                          |            | Global |     |     |   |
| TEST_STP         | BIT  | 1   | %M00107 | Test Stop                           |            | Global |     |     |   |
| GEN_RUN_OFF      | BIT  | 1   | %M00108 | Generator Run Off                   |            | Global |     |     |   |
| ENABLE_OFFLINE   | BIT  | 1   | %M00109 | Enable Generator to go Offline      |            | Global |     |     |   |
| HH_ALM_OS1       | BIT  | 1   | %M00110 | High High Alarm One Shot            |            | Global |     |     |   |
| H_ALM_OS1        | BIT  | 1   | %M00111 | High Alarm One Shot                 |            | Global |     |     |   |
| H_ALM_OS2        | BIT  | 1   | %M00112 | High Alarm One Shot                 |            | Global |     |     |   |
| M_ALM_OS1        | BIT  | 1   | %M00113 | Medium Alarm One Shot               |            | Global |     |     |   |
| M_ALM_OS2        | BIT  | 1   | %M00114 | Medium Alarm One Shot               |            | Global |     |     |   |
| M_ATS_ALM_OS1    | BIT  | 1   | %M00115 | Mains ATS Alarm One Shot            |            | Global |     |     |   |
| M_ATS_ALM_OS2    | BIT  | 1   | %M00116 | Mains ATS Alarm One Shot            |            | Global |     |     |   |
| MAINS_FAIL_STR   | BIT  | 1   | %M00117 | Mains Fail Start                    |            | Global |     |     |   |
| GEN_RUNNING      | BIT  | 1   | %M00201 | Generator Running                   |            | Global |     |     |   |
| FAIL_STR_TM      | BIT  | 1   | %M00202 | Failed to Start Time                |            | Global |     |     |   |
| FAIL_STR_DLY     | BIT  | 1   | %M00203 | Failed to Start Pulse Delay         |            | Global |     |     |   |

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A:

GLOBAL VARIABLE

| Name               | Type | Len | Address | Description                               | Stored Val | Scope  | Ret | Ovr | E |
|--------------------|------|-----|---------|---|------------|--------|-----|-----|---|
| FAIL_STR_CNT       | BIT  | 1   | %M00204 | Failed to Start Counter                   |            | Global |     |     |   |
| CRK_CUTOUT         | BIT  | 1   | %M00205 | Generator Crank Cutout                    |            | Global |     |     |   |
| ENB_STR_DLY        | BIT  | 1   | %M00206 | Enable Start Delay for Alarms             |            | Global |     |     |   |
| OIL_P_DLY          | BIT  | 1   | %M00207 | Oil Pressure Alarm Delay                  |            | Global |     |     |   |
| STR_UP_DLY         | BIT  | 1   | %M00208 | Startup Alarm Delay                       |            | Global |     |     |   |
| ATS_OPN_1          | BIT  | 1   | %M00209 | Mains ATS Open Command                    |            | Global |     |     |   |
| ATS_CLS_1          | BIT  | 1   | %M00210 | Generator ATS Close Command               |            | Global |     |     |   |
| G_ATS_OPN_1        | BIT  | 1   | %M00211 | Generator ATS Open Command                |            | Global |     |     |   |
| M_ATS_CLS_1        | BIT  | 1   | %M00212 | Mains ATS Close Command                   |            | Global |     |     |   |
| M_ATS_CLS_ENB      | BIT  | 1   | %M00213 | Mains ATS Close Enable                    |            | Global |     |     |   |
| G_ATS_CLS_ENB      | BIT  | 1   | %M00214 | Generator ATS Close Enable                |            | Global |     |     |   |
| HIGH_HIGH_ALM      | BIT  | 1   | %M00300 | High High Alarm                           |            | Global |     |     |   |
| EM_STP_ALM         | BIT  | 1   | %M00301 | Emergency Stop Alarm                      |            | Global |     |     |   |
| MEN_ALM            | BIT  | 1   | %M00302 | MEN Alarm                                 |            | Global |     |     |   |
| OIL_P_SD_ALM       | BIT  | 1   | %M00303 | Low Oil Pressure Shutdown Alarm           |            | Global |     |     |   |
| ENG_T_SD_ALM       | BIT  | 1   | %M00304 | High Engine Temperature Shutdown Alarm    |            | Global |     |     |   |
| RAD_WATER_LOW_ALM  | BIT  | 1   | %M00305 | Low Radiator Water Level Alarm            |            | Global |     |     |   |
| SPD_OVER_ALM       | BIT  | 1   | %M00306 | Over Speed Alarm                          |            | Global |     |     |   |
| RAD_WATER_LOW_DLY  | BIT  | 1   | %M00315 | Radiator Water Level Low Delay            |            | Global |     |     |   |
| SPD_OVER_DLY       | BIT  | 1   | %M00316 | Over Speed Delay Timer                    |            | Global |     |     | R |
| HIGH_ALM           | BIT  | 1   | %M00320 | High Alarm                                |            | Global |     |     |   |
| SPD_UNDER_ALM      | BIT  | 1   | %M00321 | Under Speed Alarm                         |            | Global |     |     |   |
| TS_UNDER_ALM       | BIT  | 1   | %M00322 | Alternator Voltage Under Alarm            |            | Global |     |     |   |
| VOLTS_OVER_ALM     | BIT  | 1   | %M00323 | Alternator Voltage Over Alarm             |            | Global |     |     |   |
| GEN_CB_TRIP_ALM    | BIT  | 1   | %M00324 | Generator CB Tripped Alarm                |            | Global |     |     |   |
| ALT_TEMP_ALM       | BIT  | 1   | %M00325 | Alternator High Temperature Alarm         |            | Global |     |     |   |
| SPD_UNDER_DLY      | BIT  | 1   | %M00331 | Under Speed Alarm Delay                   |            | Global |     |     |   |
| VOLTS_UNDER_DLY    | BIT  | 1   | %M00332 | Under Voltage Alarm Delay                 |            | Global |     |     |   |
| VOLTS_OVER_DLY     | BIT  | 1   | %M00333 | Over Voltage Alarm Delay                  |            | Global |     |     |   |
| MEDIUM_ALM         | BIT  | 1   | %M00340 | Medium Alarm                              |            | Global |     |     |   |
| FUEL_LEV_EMPTY_ALM | BIT  | 1   | %M00341 | Fuel Empty Alarm                          |            | Global |     |     |   |
| FAIL_TO_STR_ALM    | BIT  | 1   | %M00342 | Fail to Start Alarm                       |            | Global |     |     |   |
| FUEL_LEV_EMPTY_DLY | BIT  | 1   | %M00351 | Fuel Level Empty Alarm Delay              |            | Global |     |     |   |
| LOW_ALM            | BIT  | 1   | %M00360 | Low Alarm                                 |            | Global |     |     |   |
| OIL_P_W_ALM        | BIT  | 1   | %M00361 | Low Oil Pressure Warning Alarm            |            | Global |     |     |   |
| ENG_T_W_ALM        | BIT  | 1   | %M00362 | High Engine Temperature Warning Alarm     |            | Global |     |     |   |
| FUEL_LEV_LOW_ALM   | BIT  | 1   | %M00363 | Low Fuel Level Alarm                      |            | Global |     |     |   |
| BAT_CHG_AC_ALM     | BIT  | 1   | %M00364 | Battery Charger AC Alarm                  |            | Global |     |     |   |
| BAT_CONT_LOW_V_ALM | BIT  | 1   | %M00365 | Control Battery Charger Low Voltage Alarm |            | Global |     |     |   |
| E..._STR_LOW_V_ALM | BIT  | 1   | %M00366 | Start Battery Charger Low Voltage Alarm   |            | Global |     |     |   |
| FUEL_LEV_LOW_DLY   | BIT  | 1   | %M00373 | Fuel Level Low Alarm Delay                |            | Global |     |     | R |
| BAT_CHG_AC_DLY     | BIT  | 1   | %M00374 | Battery Charger AC Failure Delay          |            | Global |     |     | R |
| BAT_CONT_LOW_V_DLY | BIT  | 1   | %M00375 | Control Battery Low Voltage Delay         |            | Global |     |     | R |
| BAT_STR_LOW_V_DLY  | BIT  | 1   | %M00376 | Start Battery Low Voltage Delay           |            | Global |     |     | R |
| MAINS_ATS_OPN_ALM  | BIT  | 1   | %M00381 | Mains ATS Failed to Open Alarm            |            | Global |     |     |   |
| MAINS_ATS_CLS_ALM  | BIT  | 1   | %M00382 | Mains ATS Failed to Close Alarm           |            | Global |     |     |   |
| GEN_ATS_OPN_ALM    | BIT  | 1   | %M00383 | Generator ATS Failed to Open Alarm        |            | Global |     |     |   |
| GEN_ATS_CLS_ALM    | BIT  | 1   | %M00384 | Generator ATS Failed to Close Alarm       |            | Global |     |     |   |
| NEW_ALM            | BIT  | 1   | %M00400 | New Alarm                                 |            | Global |     |     | R |
| %M00401            | BIT  | 1   | %M00401 | **No Description**                        |            | Global |     |     | R |

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GLOBAL VARIABI

| Name               | Type | Len | Address | Description                                      | Stored Val | Scope  | Ret | Ovr | E |
|--------------------|------|-----|---------|--|------------|--------|-----|-----|---|
| %M00402            | BIT  | 1   | %M00402 | **No Description**                               |            | Global | R   |     |   |
| %M00403            | BIT  | 1   | %M00403 | **No Description**                               |            | Global | R   |     |   |
| %M00404            | BIT  | 1   | %M00404 | **No Description**                               |            | Global | R   |     |   |
| %M00405            | BIT  | 1   | %M00405 | **No Description**                               |            | Global | R   |     |   |
| %M00406            | BIT  | 1   | %M00406 | **No Description**                               |            | Global | R   |     |   |
| %M00421            | BIT  | 1   | %M00421 | **No Description**                               |            | Global | R   |     |   |
| %M00422            | BIT  | 1   | %M00422 | **No Description**                               |            | Global | R   |     |   |
| %M00423            | BIT  | 1   | %M00423 | **No Description**                               |            | Global | R   |     |   |
| %M00424            | BIT  | 1   | %M00424 | **No Description**                               |            | Global | R   |     |   |
| %M00425            | BIT  | 1   | %M00425 | **No Description**                               |            | Global | R   |     |   |
| %M00441            | BIT  | 1   | %M00441 | **No Description**                               |            | Global | R   |     |   |
| %M00442            | BIT  | 1   | %M00442 | **No Description**                               |            | Global | R   |     |   |
| %M00461            | BIT  | 1   | %M00461 | **No Description**                               |            | Global | R   |     |   |
| %M00462            | BIT  | 1   | %M00462 | **No Description**                               |            | Global | R   |     |   |
| %M00463            | BIT  | 1   | %M00463 | **No Description**                               |            | Global | R   |     |   |
| %M00464            | BIT  | 1   | %M00464 | **No Description**                               |            | Global | R   |     |   |
| %M00465            | BIT  | 1   | %M00465 | **No Description**                               |            | Global | R   |     |   |
| %M00466            | BIT  | 1   | %M00466 | **No Description**                               |            | Global | R   |     |   |
| %M00481            | BIT  | 1   | %M00481 | **No Description**                               |            | Global | R   |     |   |
| %M00482            | BIT  | 1   | %M00482 | **No Description**                               |            | Global | R   |     |   |
| %M00483            | BIT  | 1   | %M00483 | **No Description**                               |            | Global | R   |     |   |
| %M00484            | BIT  | 1   | %M00484 | **No Description**                               |            | Global | R   |     |   |
| AUTO_IND           | BIT  | 1   | %Q00001 | Controls in Auto Indicator                       |            | Global |     |     |   |
| TEST_IND           | BIT  | 1   | %Q00002 | Controls in Test Indicator                       |            | Global |     |     |   |
| MAN_IND            | BIT  | 1   | %Q00003 | Controls in Manual Indicator                     |            | Global |     |     |   |
| REM_STR_IND        | BIT  | 1   | %Q00004 | Remote Start Indicator                           |            | Global |     |     |   |
| MAINS_AVAIL_IND    | BIT  | 1   | %Q00005 | Mains Available Indicator                        |            | Global |     |     |   |
| MAINS_CON_IND      | BIT  | 1   | %Q00006 | Mains Connected Indicator                        |            | Global |     |     |   |
| GEN_RUN_IND        | BIT  | 1   | %Q00007 | Generator Running Indicator                      |            | Global |     |     |   |
| GEN_CON_IND        | BIT  | 1   | %Q00008 | Generator Connected<br>Indicated                 |            | Global |     |     |   |
| MAINS_FAILED_IND   | BIT  | 1   | %Q00009 | Mains Failed Indicator                           |            | Global |     |     |   |
| EM_STOP_IND        | BIT  | 1   | %Q00010 | Emergency Stop Indicator                         |            | Global |     |     |   |
| MEN_FLT_IND        | BIT  | 1   | %Q00011 | MEN Fault Indicator                              |            | Global |     |     |   |
| OIL_P_LOW_SD_IND   | BIT  | 1   | %Q00012 | Low Oil Pressure Shutdown<br>Indicator           |            | Global |     |     |   |
| OIL_P_LOW_W_IND    | BIT  | 1   | %Q00013 | Low Oil Pressure Warning<br>Indicator            |            | Global |     |     |   |
| ENG_T_HI_SD_IND    | BIT  | 1   | %Q00014 | High Engine Temperature<br>Shutdown Indicator    |            | Global |     |     |   |
| ENG_T_HI_W_IND     | BIT  | 1   | %Q00015 | High Engine Temperature<br>Warning Indicator     |            | Global |     |     |   |
| RAD_WATER_LOW_IND  | BIT  | 1   | %Q00016 | Low Radiator Water Level<br>Indicator            |            | Global |     |     |   |
| FUEL_LEV_EMPTY_IND | BIT  | 1   | %Q00017 | Fuel Empty Indicator                             |            | Global |     |     |   |
| FUEL_LEV_LOW_IND   | BIT  | 1   | %Q00018 | Low Fuel Level Indicator                         |            | Global |     |     |   |
| SPD_OVER_IND       | BIT  | 1   | %Q00019 | Over Speed Indicator                             |            | Global |     |     |   |
| SPD_UNDER_IND      | BIT  | 1   | %Q00020 | Under Speed Indicator                            |            | Global |     |     |   |
| FAIL_TO_STR_IND    | BIT  | 1   | %Q00021 | Fail to Start Indicator                          |            | Global |     |     |   |
| VOLTS_UNDER_IND    | BIT  | 1   | %Q00022 | Alternator Voltage Under<br>Indicator            |            | Global |     |     |   |
| VOLTS_OVER_IND     | BIT  | 1   | %Q00023 | Alternator Voltage Over<br>Indicator             |            | Global |     |     |   |
| ALT_TEMP_IND       | BIT  | 1   | %Q00024 | Alternator High Temperature<br>Indicator         |            | Global |     |     |   |
| GEN_CB_TRIP_IND    | BIT  | 1   | %Q00025 | Generator CB Tripped<br>Indicator                |            | Global |     |     |   |
| BAT_CHG_AC_IND     | BIT  | 1   | %Q00026 | Battery Charger AC Indicator                     |            | Global |     |     |   |
| BAT_CONT_LOW_V_IND | BIT  | 1   | %Q00027 | Control Battery Charger Low<br>Voltage Indicator |            | Global |     |     |   |
| BAT_STR_LOW_V_IND  | BIT  | 1   | %Q00028 | Start Battery Charger Low<br>Voltage Indicator   |            | Global |     |     |   |
| CAN_DOORS_OPEN_IND | BIT  | 1   | %Q00029 | Canopy Doors Open<br>Indicator                   |            | Global |     |     |   |
| MAINS_ATS_OPN_CMD  | BIT  | 1   | %Q00033 | BCC Mains ATS Open<br>Command                    |            | Global |     |     |   |
| GEN_ATS_CLS_CMD    | BIT  | 1   | %Q00034 | BCC Generator ATS Close<br>Command               |            | Global |     |     |   |
| GEN_SD_ALM         | BIT  | 1   | %Q00035 | BCC Generator Shutdown<br>Alarm                  |            | Global |     |     |   |
| GEN_W_ALM          | BIT  | 1   | %Q00036 | BCC Generator Warning<br>Alarm                   |            | Global |     |     |   |

Program: BCC\_4000\_4

A:

GLOBAL VARIABLE

| Name            | Type | Len | Address | Description  | Stored Val | Scope  | Ret | Ovr | E |
|-----------------|------|-----|---------|--|------------|--------|-----|-----|---|
| FUEL_LOW        | BIT  | 1   | %Q00037 | BCC Low Fuel   |            | Global |     |     |   |
| GEN_RUN         | BIT  | 1   | %Q00038 | BCC Generator Running                                      |            | Global |     |     |   |
| GEN_CON         | BIT  | 1   | %Q00039 | BCC Generator Connected                                    |            | Global |     |     |   |
| SMR             | BIT  | 1   | %Q00040 | Starter Motor Relay  |            | Global |     |     |   |
| GCR             | BIT  | 1   | %Q00041 | Governor Control Relay                                     |            | Global |     |     |   |
| ALAR            | BIT  | 1   | %Q00042 | Audible Alarm Relay  |            | Global |     |     |   |
| SHTR            | BIT  | 1   | %Q00043 | Generator Shunt Trip Relay                                 |            | Global |     |     |   |
| DOORS_OPEN      | BIT  | 1   | %Q00044 | BCC Doors Open Alarm                                       |            | Global |     |     |   |
| GEN_AUTO        | BIT  | 1   | %Q00045 | Generator Auto Mode  |            | Global |     |     |   |
| SEQ_CNT         | WORD | 1   | %R00001 | Sequence Counter   |            | Global |     |     | R |
| MODBUS_INPUTS   | WORD | 1   | %R00002 | Modbus Digital Inputs                                      |            | Global |     |     | R |
| MODBUS_OUTPUTS  | WORD | 1   | %R00005 | Modbus Digital Outputs                                     |            | Global |     |     | R |
| MODBUS_STATUS_1 | WORD | 1   | %R00008 | Modbus Status 1  |            | Global |     |     | R |
| MODBUS_STATUS_2 | WORD | 1   | %R00009 | Modbus Status 2  |            | Global |     |     | R |
| MODBUS_ALARMS   | WORD | 1   | %R00010 | Modbus Alarms  |            | Global |     |     | R |
| %R00100         | WORD | 3   | %R00100 | **No Description**   |            | Global |     |     | R |
| %R00103         | WORD | 3   | %R00103 | **No Description**   |            | Global |     |     | R |
| %R00106         | WORD | 3   | %R00106 | **No Description**   |            | Global |     |     | R |
| %R00109         | WORD | 3   | %R00109 | **No Description**   |            | Global |     |     | R |
| %R00112         | WORD | 3   | %R00112 | **No Description**   |            | Global |     |     | R |
| %R00115         | WORD | 3   | %R00115 | **No Description**   |            | Global |     |     | R |
| %R00118         | WORD | 3   | %R00118 | **No Description**   |            | Global |     |     | R |
| %R00121         | WORD | 3   | %R00121 | **No Description**   |            | Global |     |     | R |
| %R00124         | WORD | 3   | %R00124 | **No Description**   |            | Global |     |     | R |
| %R00127         | WORD | 3   | %R00127 | **No Description**   |            | Global |     |     | R |
| %R00130         | WORD | 3   | %R00130 | **No Description**   |            | Global |     |     | R |
| %R00133         | WORD | 3   | %R00133 | **No Description**   |            | Global |     |     | R |
| %R00136         | WORD | 3   | %R00136 | **No Description**   |            | Global |     |     | R |
| 0139            | WORD | 3   | %R00139 | **No Description**   |            | Global |     |     | R |
| 0200            | WORD | 3   | %R00200 | **No Description**   |            | Global |     |     | R |
| %R00203         | WORD | 3   | %R00203 | **No Description**   |            | Global |     |     | R |
| %R00206         | WORD | 3   | %R00206 | **No Description**   |            | Global |     |     | R |
| %R00209         | WORD | 3   | %R00209 | **No Description**   |            | Global |     |     | R |
| %R00212         | WORD | 3   | %R00212 | **No Description**   |            | Global |     |     | R |
| %R00215         | WORD | 3   | %R00215 | **No Description**   |            | Global |     |     | R |
| %R00218         | WORD | 3   | %R00218 | **No Description**   |            | Global |     |     | R |
| %R00221         | WORD | 3   | %R00221 | **No Description**   |            | Global |     |     | R |
| %R00224         | WORD | 3   | %R00224 | **No Description**   |            | Global |     |     | R |
| %R00227         | WORD | 3   | %R00227 | **No Description**   |            | Global |     |     | R |
| %R00230         | WORD | 3   | %R00230 | **No Description**   |            | Global |     |     | R |
| %R00300         | WORD | 3   | %R00300 | **No Description**   |            | Global |     |     | R |
| %R00303         | WORD | 3   | %R00303 | **No Description**   |            | Global |     |     | R |
| %R00306         | WORD | 3   | %R00306 | **No Description**   |            | Global |     |     | R |
| %R00309         | WORD | 3   | %R00309 | **No Description**   |            | Global |     |     | R |
| %R00312         | WORD | 3   | %R00312 | **No Description**   |            | Global |     |     | R |
| %R00315         | WORD | 3   | %R00315 | **No Description**   |            | Global |     |     | R |
| %R00318         | WORD | 3   | %R00318 | **No Description**   |            | Global |     |     | R |
| %R00321         | WORD | 3   | %R00321 | **No Description**   |            | Global |     |     | R |
| %R00324         | WORD | 3   | %R00324 | **No Description**   |            | Global |     |     | R |
| %R00327         | WORD | 3   | %R00327 | **No Description**   |            | Global |     |     | R |
| %R00330         | WORD | 3   | %R00330 | **No Description**   |            | Global |     |     | R |
| %0333           | WORD | 3   | %R00333 | **No Description**   |            | Global |     |     | R |
| %0336           | WORD | 3   | %R00336 | **No Description**   |            | Global |     |     | R |
| %R00339         | WORD | 3   | %R00339 | **No Description**   |            | Global |     |     | R |
| FST_SCN         | BIT  | 1   | %S00001 | Set to 1 when the current sweep is the first sweep         |            | Global |     |     | R |
| LST_SCAN        | BIT  | 1   | %S00002 | Reset from 1 to 0 when the current sweep is the last sweep |            | Global |     |     | R |
| T_10MS          | BIT  | 1   | %S00003 | 0.01 Second Timer Contact                                  |            | Global |     |     | R |
| T_100MS         | BIT  | 1   | %S00004 | 0.1 Second Timer Contact                                   |            | Global |     |     | R |
| T_1S            | BIT  | 1   | %S00005 | 1 Second Timer Contact                                     |            | Global |     |     | R |
| T_1M            | BIT  | 1   | %S00006 | 1 Minute Timer Contact                                     |            | Global |     |     | R |
| ALW_ON          | BIT  | 1   | %S00007 | Always ON  |            | Global |     |     | R |
| ALW_OFF         | BIT  | 1   | %S00008 | Always OFF   |            | Global |     |     | R |
| PLC_BAT         | BIT  | 1   | %S00014 | Set to indicate a bad battery in the CPU                   |            | Global |     |     | R |
| %R00400         | WORD | 1   | %R00400 | **No Description**   |            | Global |     |     | R |

Program: BCC\_4000\_4

A:

GLOBAL VARIABLE

| Name    | Type | Len | Address | Description  | Stored Val | Scope  | Ret | Ovr | E |
|---------|------|-----|---------|--|------------|--------|-----|-----|---|
| FST_SCN | BIT  | 1   | %S00001 | Set to 1 when the current sweep is the first sweep               |            | System | R   |     |   |
| LST_SCN | BIT  | 1   | %S00002 | Reset from 1 to 0 when the current sweep is the last sweep       |            | System | R   |     |   |
| T_10MS  | BIT  | 1   | %S00003 | 0.01 second timer contact  |            | System | R   |     |   |
| T_100MS | BIT  | 1   | %S00004 | 0.1 second timer contact   |            | System | R   |     |   |
| T_SEC   | BIT  | 1   | %S00005 | 1.0 second timer contact   |            | System | R   |     |   |
| T_MIN   | BIT  | 1   | %S00006 | 1.0 minute timer contact   |            | System | R   |     |   |
| ALW_ON  | BIT  | 1   | %S00007 | Always ON  |            | System | R   |     |   |
| ALW_OFF | BIT  | 1   | %S00008 | Always OFF   |            | System | R   |     |   |
| SY_FULL | BIT  | 1   | %S00009 | Set when the PLC fault table fills up                            |            | System | R   |     |   |
| IO_FULL | BIT  | 1   | %S00010 | Set when the I/O fault table fills up                            |            | System | R   |     |   |
| OVR_PRE | BIT  | 1   | %S00011 | Set when an override exists in %I, %Q, %M or %G memory           |            | System | R   |     |   |
| PRG_CHK | BIT  | 1   | %S00013 | Set when background program check is active                      |            | System | R   |     |   |
| PLC_BAT | BIT  | 1   | %S00014 | Set to indicate a bad battery in a Release 4 or later CPU        |            | System | R   |     |   |
| SNPXACT | BIT  | 1   | %S00017 | SNP-X host is actively attached to the CPU                       |            | System | R   |     |   |
| SNPX_RD | BIT  | 1   | %S00018 | SNP-X host has read data from the CPU                            |            | System | R   |     |   |
| SNPX_WT | BIT  | 1   | %S00019 | SNP-X host has written data to the CPU                           |            | System | R   |     |   |
| RLTN_OK | BIT  | 1   | %S00020 | Set ON when a relational function using REAL data is success     |            | System | R   |     |   |
| CONTCN  | BIT  | 1   | %S00032 | Reserved for use by the programming software for cont contact    |            | System | R   |     |   |
| PB_SUM  | BIT  | 1   | %SA0001 | Set when PLC checksum does not match app checksum                |            | System | R   |     |   |
| OV_SWP  | BIT  | 1   | %SA0002 | Set when PLC sweep time is longer than user specified sweep time |            | System | R   |     |   |
| APL_FLT | BIT  | 1   | %SA0003 | Set when an application fault occurs                             |            | System | R   |     |   |
| CFG_MM  | BIT  | 1   | %SA0009 | Set when a config mismatch is detected during system powerup     |            | System | R   |     |   |
| HRD_CPU | BIT  | 1   | %SA0010 | Set when the diagnostics detects a problem with the CPU hardware |            | System | R   |     |   |
| LOW_BAT | BIT  | 1   | %SA0011 | Set when a low battery fault occurs                              |            | System | R   |     |   |
| LOS_RCK | BIT  | 1   | %SA0012 | Set when an expansion rack stops communicating with the CPU      |            | System | R   |     |   |
| LOS_IOM | BIT  | 1   | %SA0014 | Set when an I/O module stops communicating with the PLC CPU      |            | System | R   |     |   |
| LOS_SIO | BIT  | 1   | %SA0015 | Set when an option module stops communicating with the PLC CPU   |            | System | R   |     |   |
| ADD_RCK | BIT  | 1   | %SA0017 | Set when an expansion rack is added to the system                |            | System | R   |     |   |
| ADD_IOM | BIT  | 1   | %SA0019 | Set when an I/O module is added to a rack                        |            | System | R   |     |   |
| ADD_SIO | BIT  | 1   | %SA0020 | Set when an option module is added to a rack                     |            | System | R   |     |   |
| HRD_SIO | BIT  | 1   | %SA0027 | Set when a hardware failure is detected in an option module      |            | System | R   |     |   |
| SFT_SIO | BIT  | 1   | %SA0031 | Set when an unrecoverable fault is detected in an option module  |            | System | R   |     |   |
| BAD_RAM | BIT  | 1   | %SB0010 | Set when the CPU detects   |            | System | R   |     |   |

Program: BCC\_4000\_4

A:

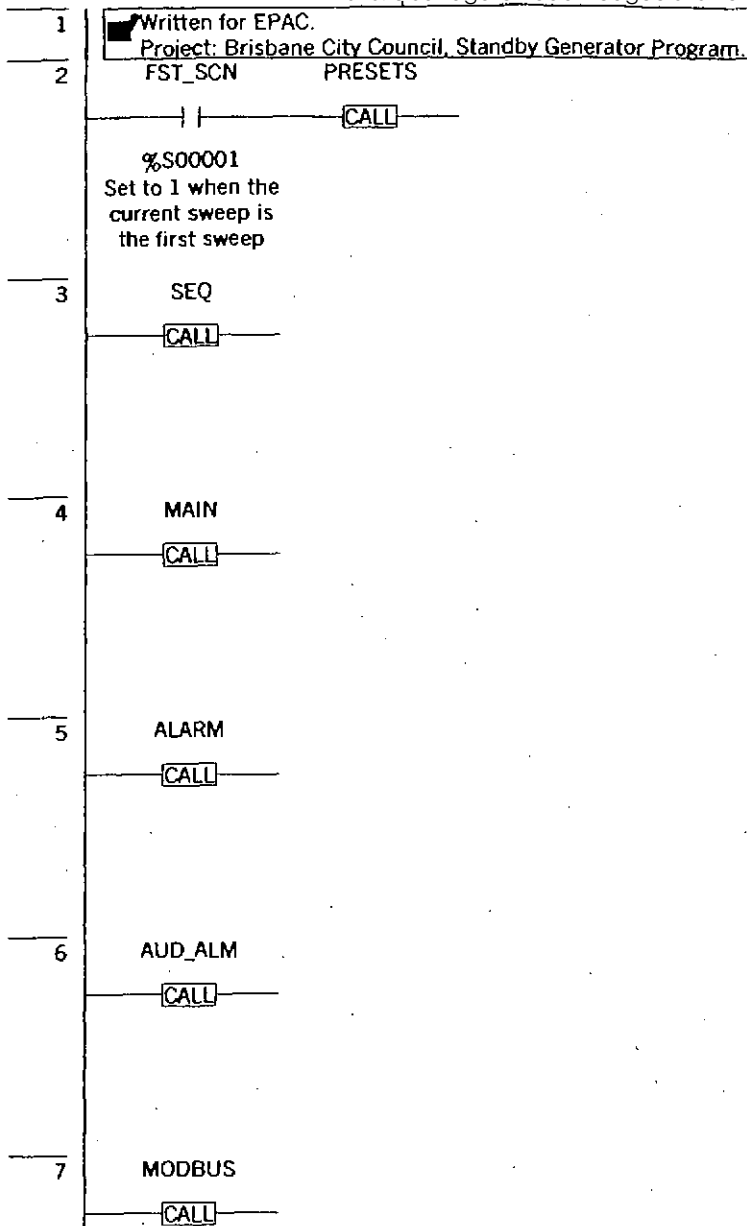
SYSTEM VARIABLE

| Name    | Type | Len | Address | Description   | Stored Val | Scope  | Ret | Ovr | Ex |
|---------|------|-----|---------|---|------------|--------|-----|-----|----|
| BAD_PWD | BIT  | 1   | %SB0011 | corrupted RAM memory at powerup<br>Set when a password violation occurs |            | System | R   |     |    |
| SFT_CPU | BIT  | 1   | %SB0013 | Set when the CPU detects an unrecoverable error in the software         |            | System | R   |     |    |
| STOR_ER | BIT  | 1   | %SB0014 | Set when an error occurs during a programmer store operation            |            | System | R   |     |    |
| ANY_FLT | BIT  | 1   | %SC0009 | Set when any fault occurs   |            | System | R   |     |    |
| SY_FLT  | BIT  | 1   | %SC0010 | Set when fault occurs where an entry is put in the PLC fault tbl        |            | System | R   |     |    |
| IO_FLT  | BIT  | 1   | %SC0011 | Set when fault occurs where an entry is put in the I/O fault tbl        |            | System | R   |     |    |
| SY_PRES | BIT  | 1   | %SC0012 | Set as long as there is at least one entry in the PLC fault tbl         |            | System | R   |     |    |
| IO_PRES | BIT  | 1   | %SC0013 | Set as long as there is at least one entry in the I/O fault tbl         |            | System | R   |     |    |
| HRD_FLT | BIT  | 1   | %SC0014 | Set when a hardware fault occurs  |            | System | R   |     |    |
| SFT_FLT | BIT  | 1   | %SC0015 | Set when a software fault occurs  |            | System | R   |     |    |

Program: BCC\_4000\_4

A:

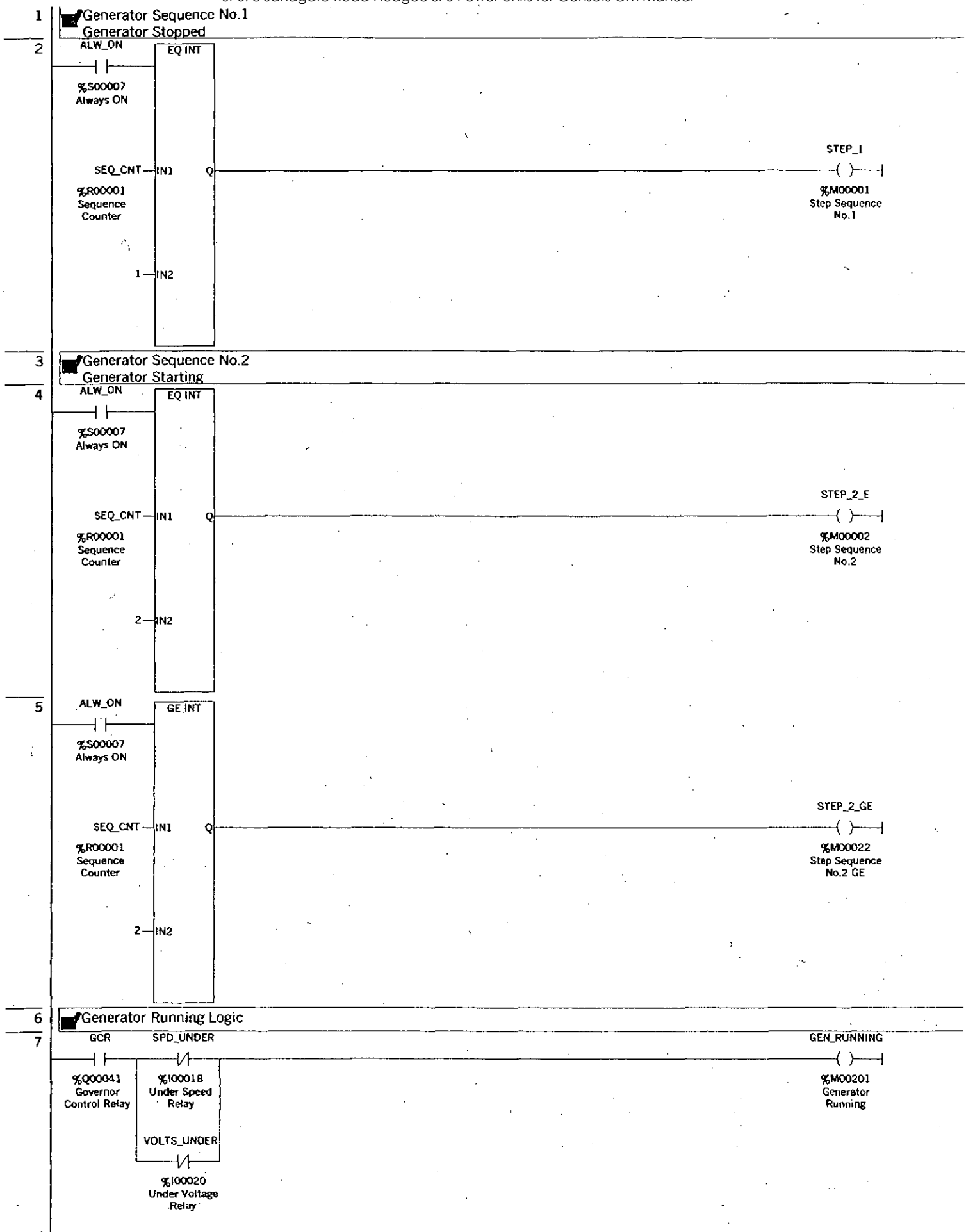
SYSTEM VARIABLE



Program: BCC\_4000\_4

A:

M



Program: BCC\_4000\_4

A:

M:

# Generator Starter Motor and Governor Logic

STEP\_2\_E SPD\_STP\_CRK FAIL\_STR\_TM CRK\_CUTOUT

SMR

%M00002 Step Sequence No.2  
%I00017 Crank Cutout Relay  
%M00202 Failed to Start Time  
%M00205 Generator Crank Cutout

%Q00040 Starter Motor Relay

STEP\_2\_GE HIGH\_HIGH\_A...

GCR

%M00022 Step Sequence No.2 GE  
%M00300 High High Alarm

%Q00041 Governor Control Relay

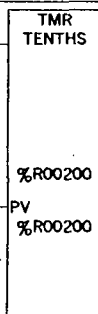
## Generator Fail To Start Timers and Counters

STEP\_2\_E SPD\_STP\_CRK FAIL\_STR\_DLY

FAIL\_STR\_TM

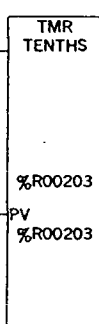
%M00002 Step Sequence No.2  
%I00017 Crank Cutout Relay  
%M00203 Failed to Start Pulse Delay

%M00202 Failed to Start Time



FAIL\_STR\_TM

%M00202 Failed to Start Time

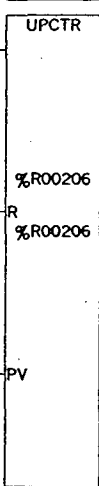


FAIL\_STR\_DLY

%M00203 Failed to Start Pulse Delay

FAIL\_STR\_TM

%M00202 Failed to Start Time



FAIL\_STR\_CNT

%M00204 Failed to Start Counter

STEP\_2\_E

%M00002 Step Sequence No.2

STEP\_2\_E

%M00002 Step Sequence No.2

GCR

%Q00041 Governor Control Relay

SPD\_STP\_CRK

%I00017 Crank Cutout Relay

FAIL\_STR\_TM

%M00202 Failed to Start Time

TMR TENTHS

%R00209

10 PV %R00209

CRK\_CUTOUT

%M00205 Generator Crank Cutout

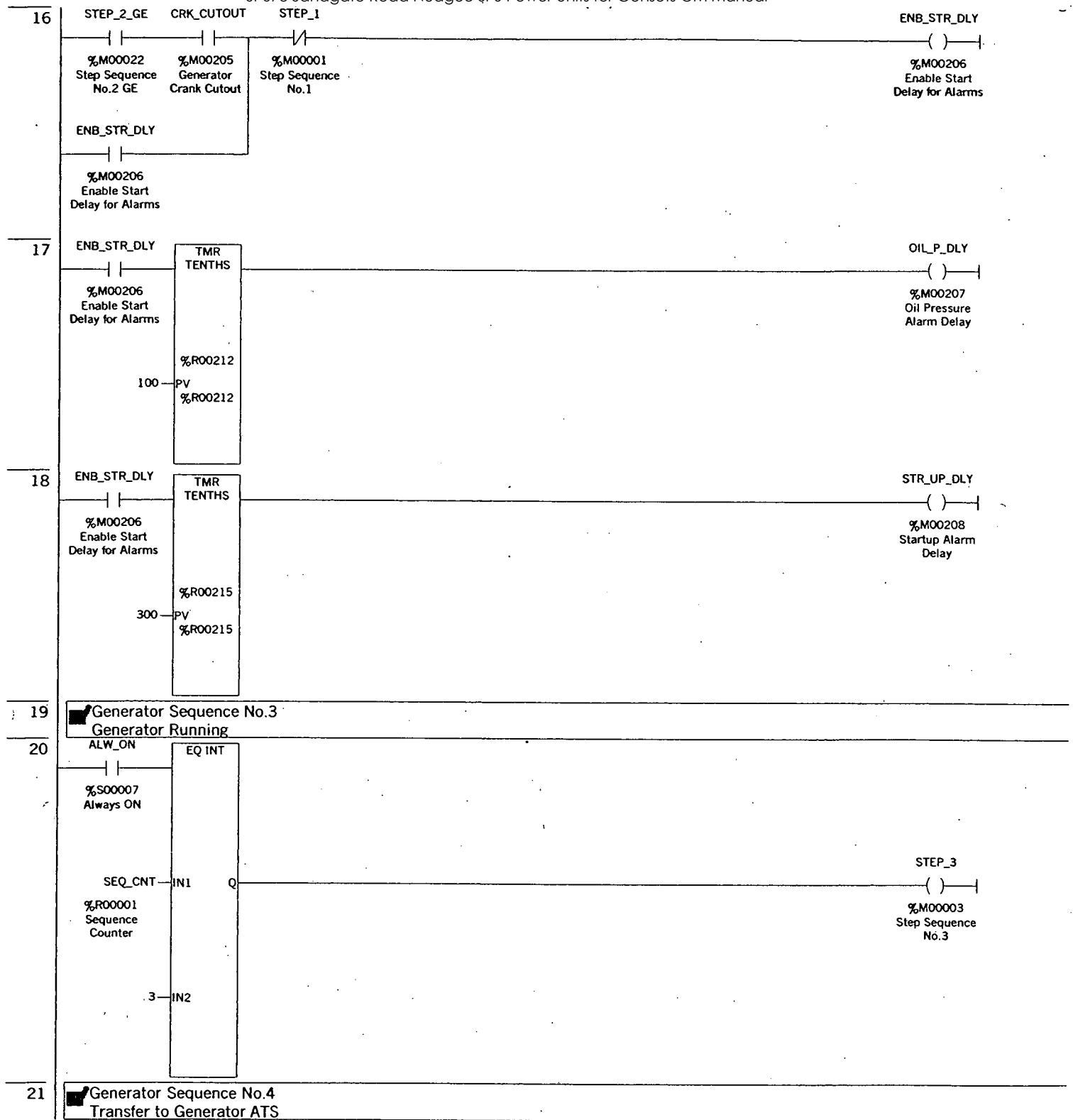
CRK\_CUTOUT

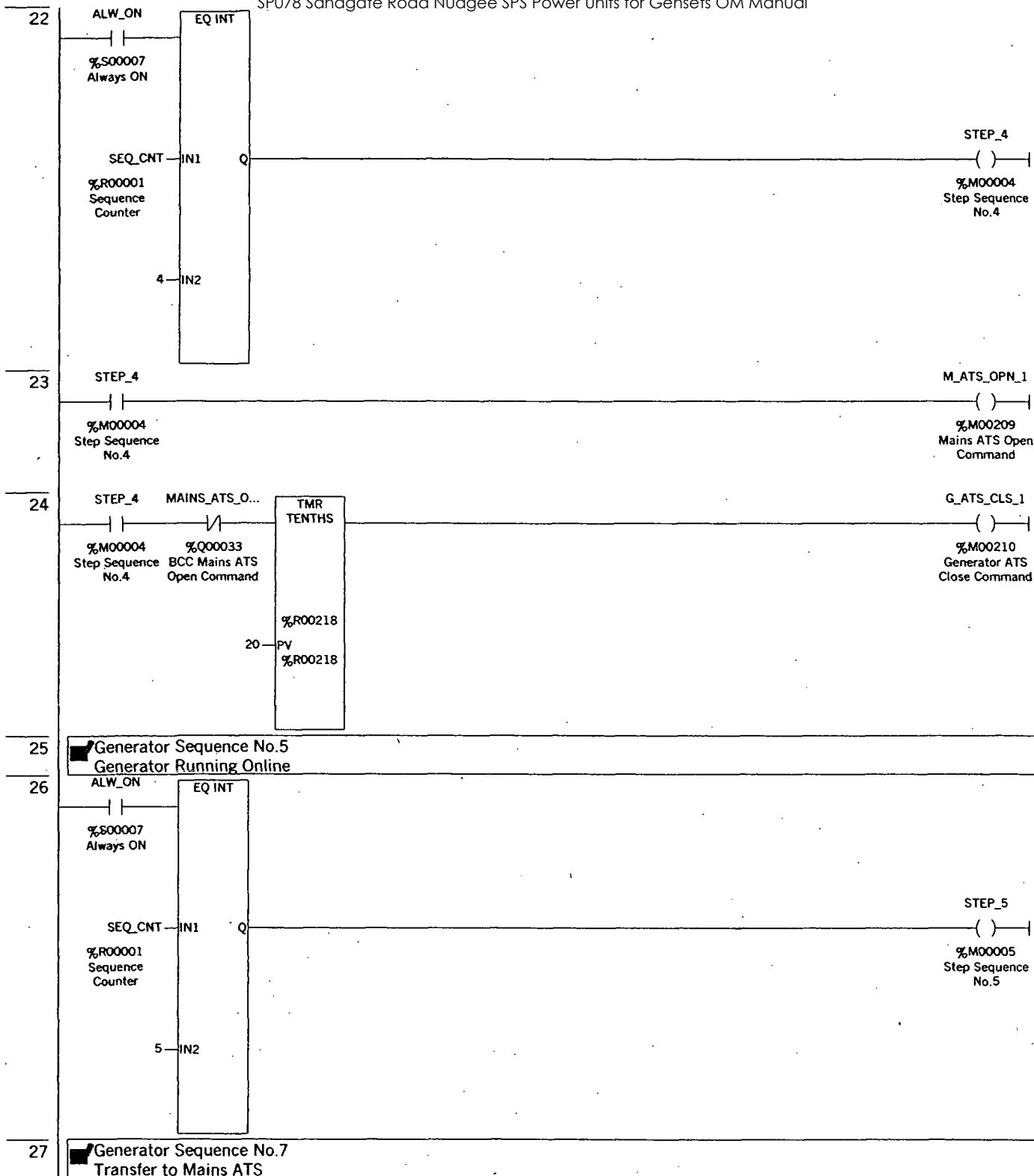
%M00205 Generator Crank Cutout

Program: BCC\_4000\_4

A:

M/

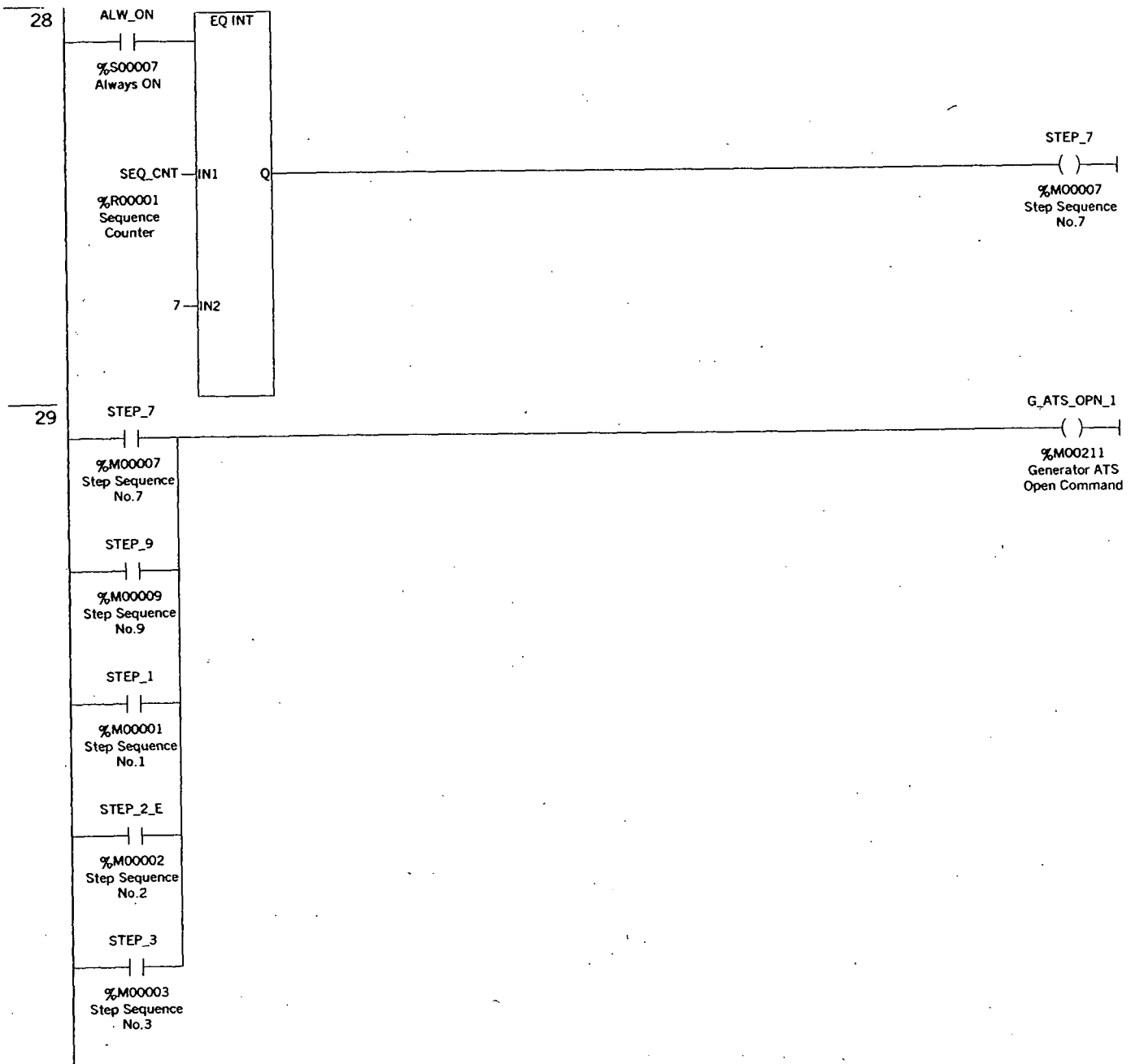




Program: BCC\_4000\_4

A:

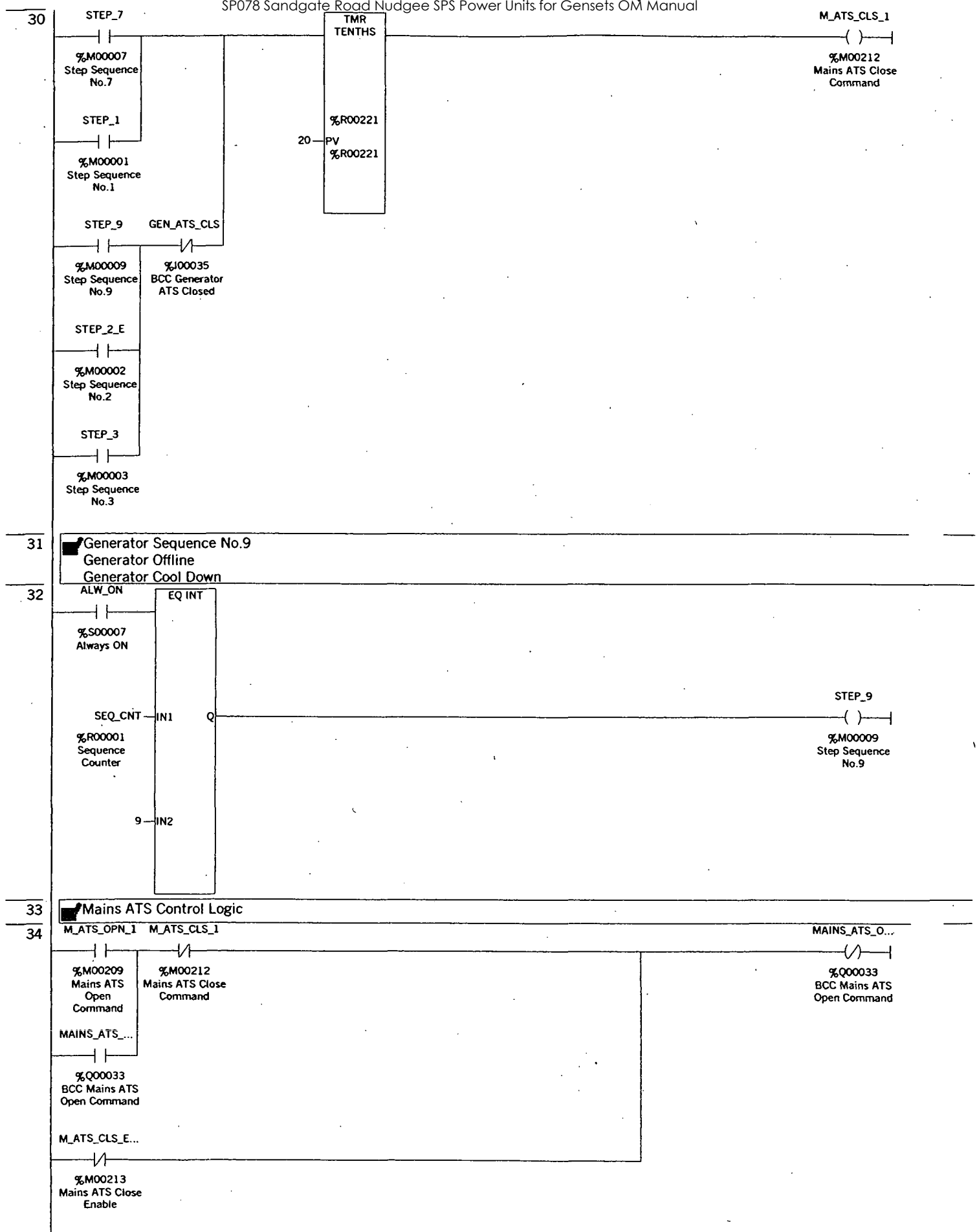
M/



Program: BCC\_4000\_4

A:

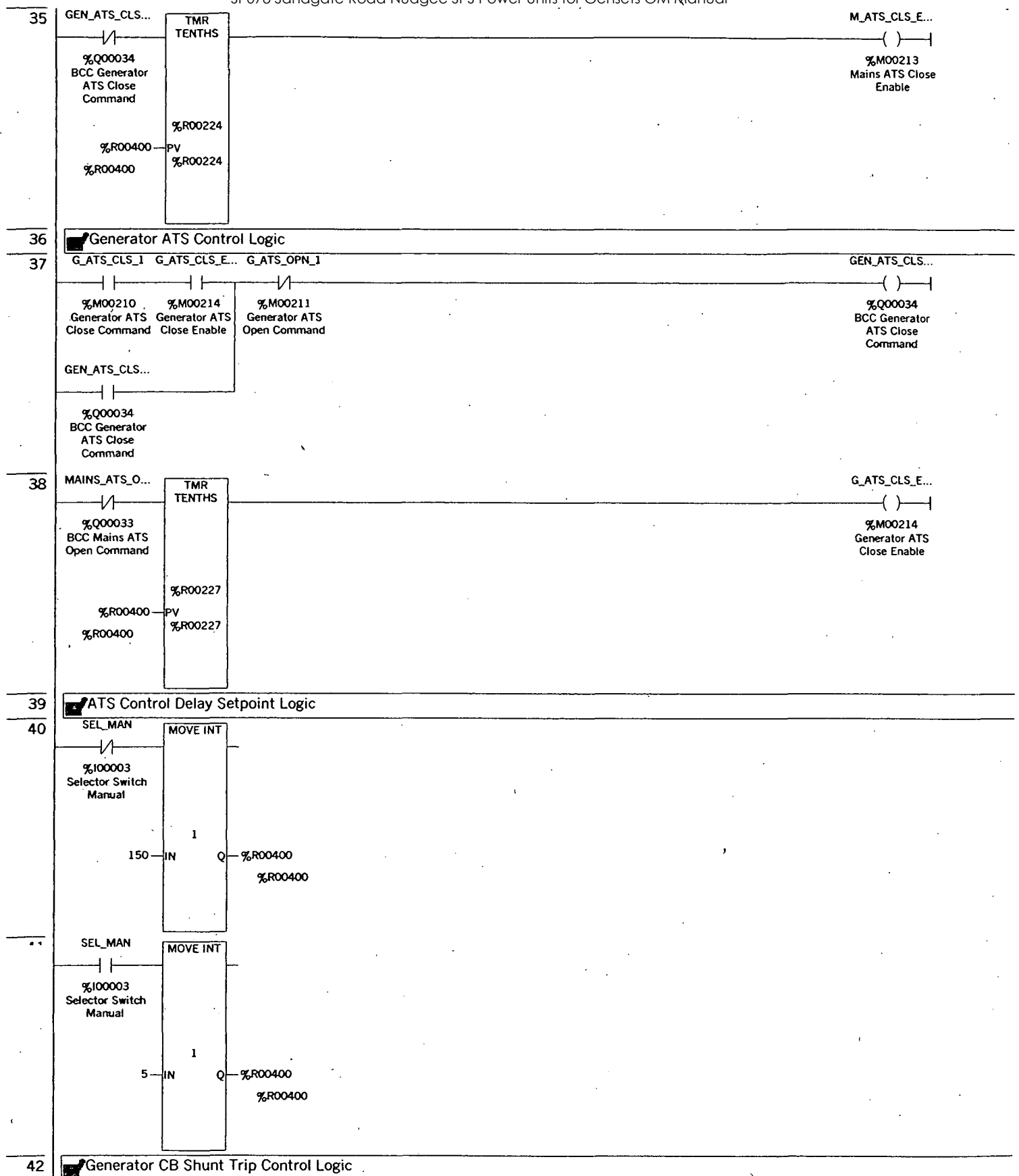
M:



Program: BCC\_4000\_4

A:

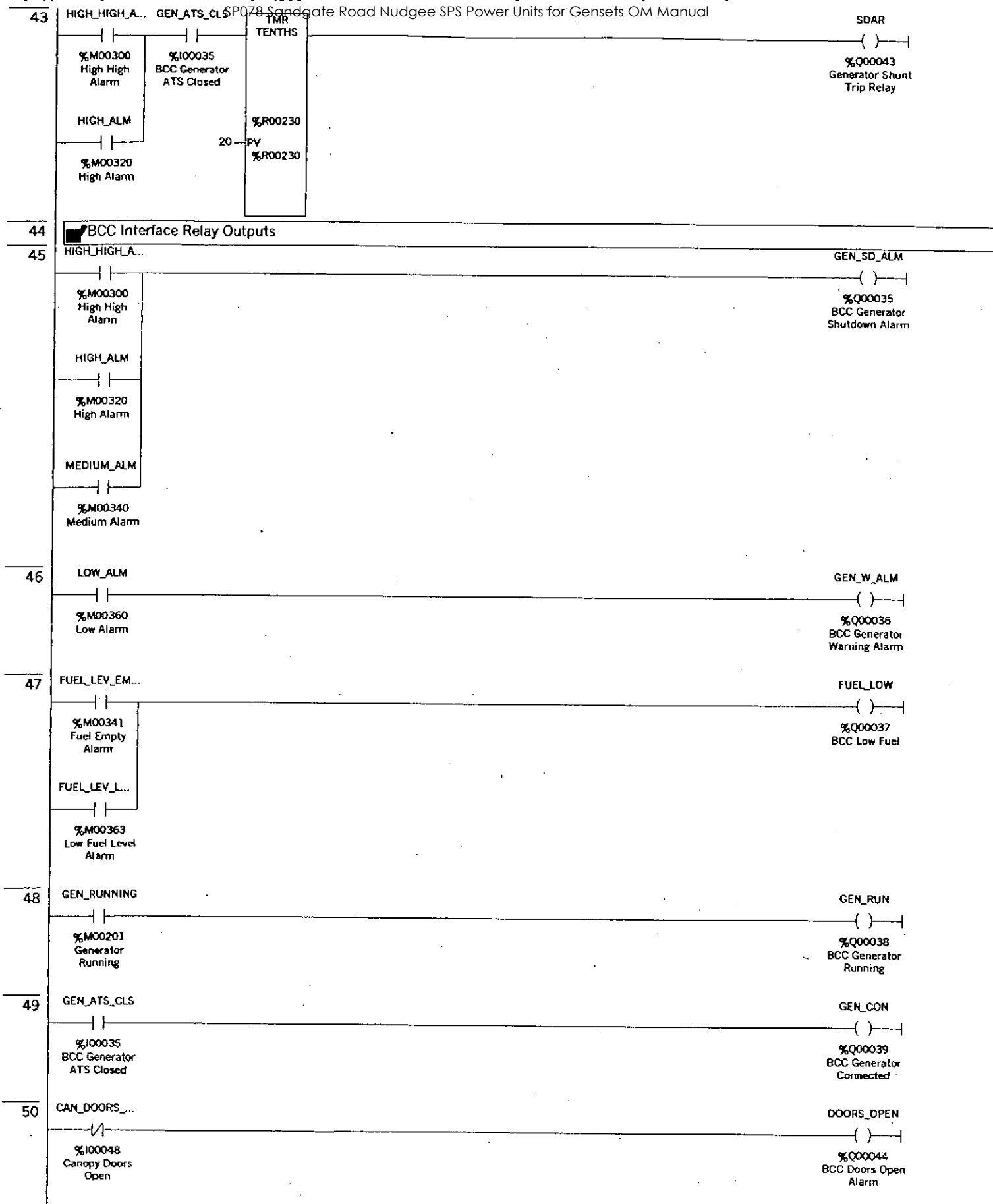
M



Program: BCC\_4000\_4

A:

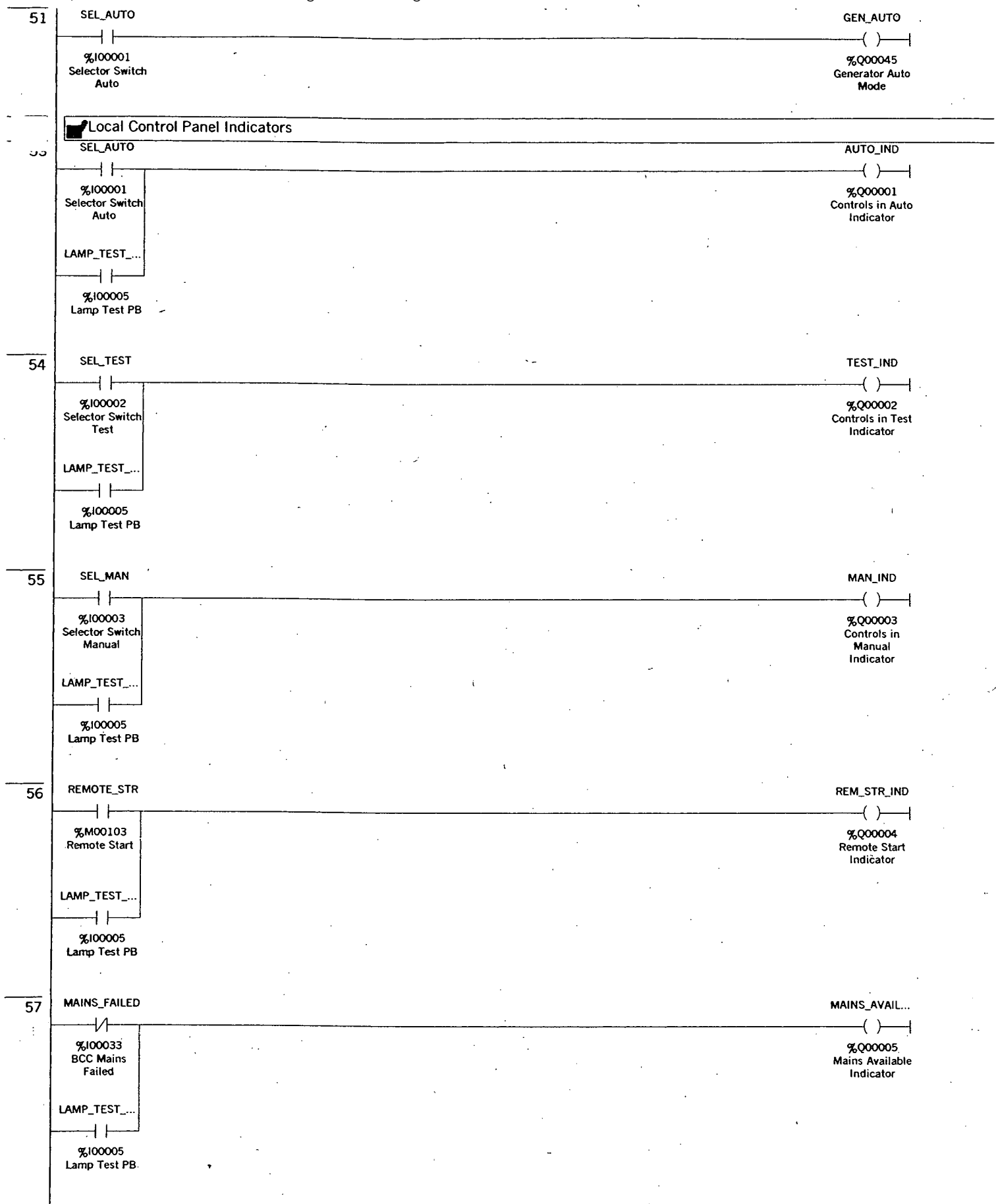
M:



Program: BCC\_4000\_4

A:

M:



Program: BCC\_4000\_4

A:

M

11/06/04 2:41:58

62

CAN\_DOORS\_...

CAN\_DOORS\_...

||  
%I00048  
Canopy Doors  
Open  
LAMP\_TEST\_...  
||  
%I00005  
Lamp Test PB

( )  
%Q00029  
Canopy Doors  
Open Indicator

Program: BCC\_4000\_4

A:

M

1

Presets Routine  
Move 1 to the Sequence Counter

2

ALW\_ON

MOVE INT

%S00007  
Always ON

1

1-IN

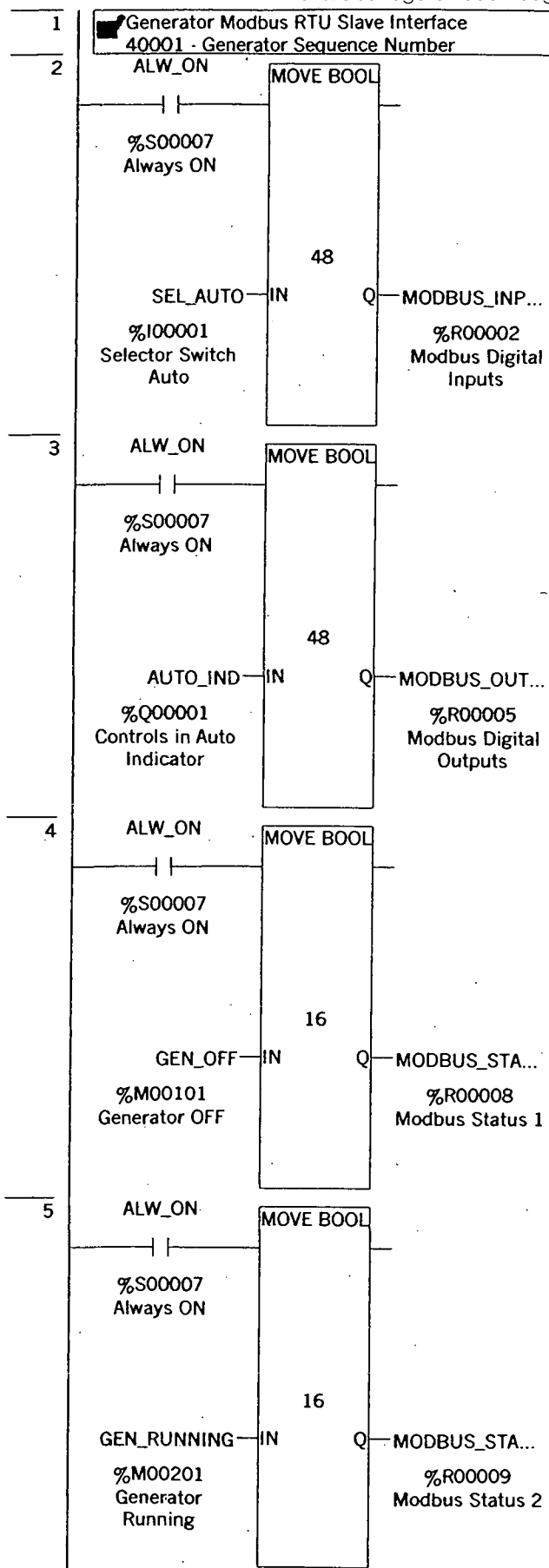
Q-SEQ\_CNT

%R00001  
Sequence  
Counter

Program: BCC\_4000\_4

A:

PRESI



Program: BCC\_4000\_4

A:

DDI

6

ALW\_ON

MOVE BOOL

%S00007  
Always ON

100

HIGH\_HIGH\_ALM IN

%M00300  
High High Alarm

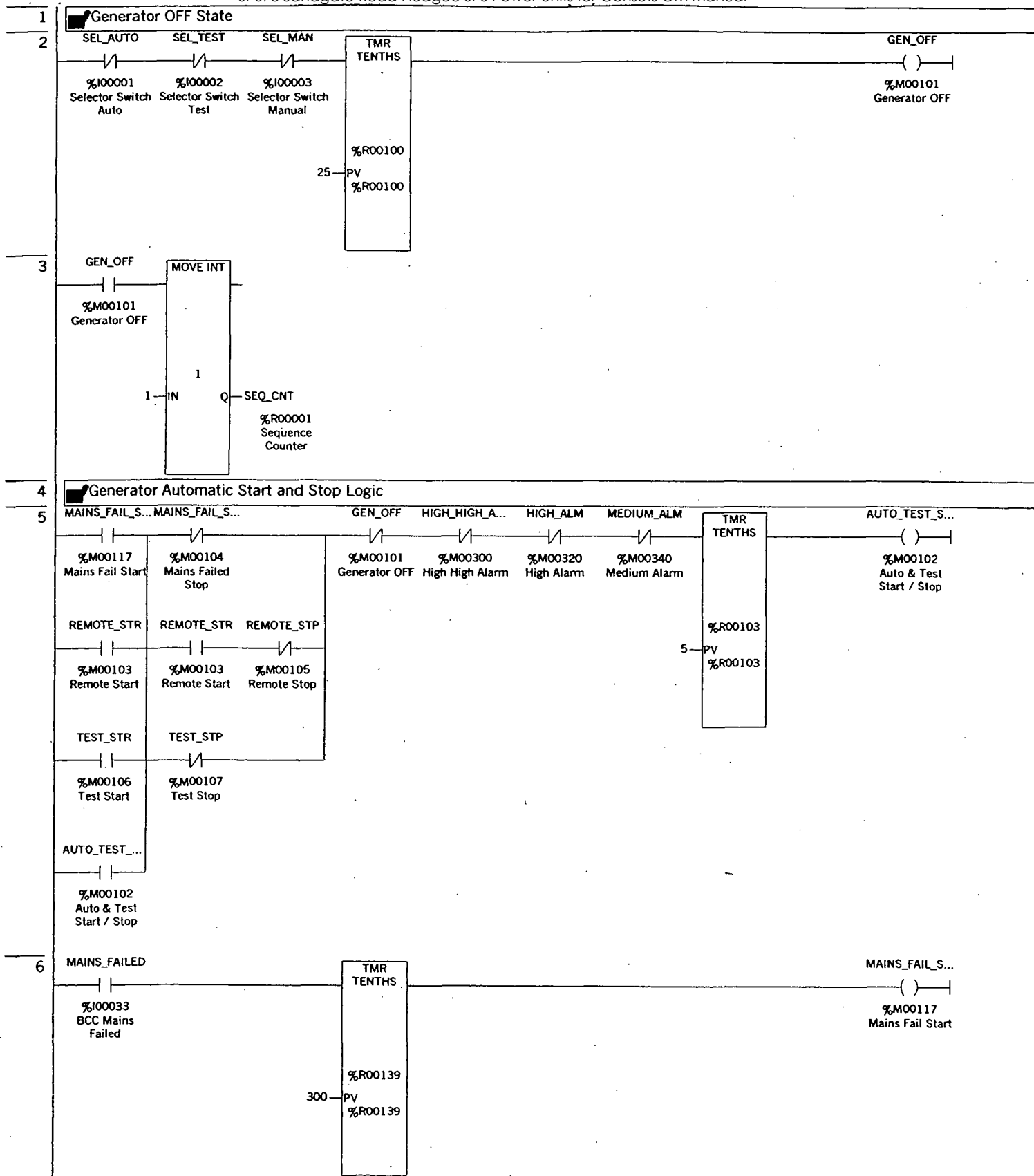
Q MODBUS\_ALA...

%R00010  
Modbus Alarms

Program: BCC\_4000\_4

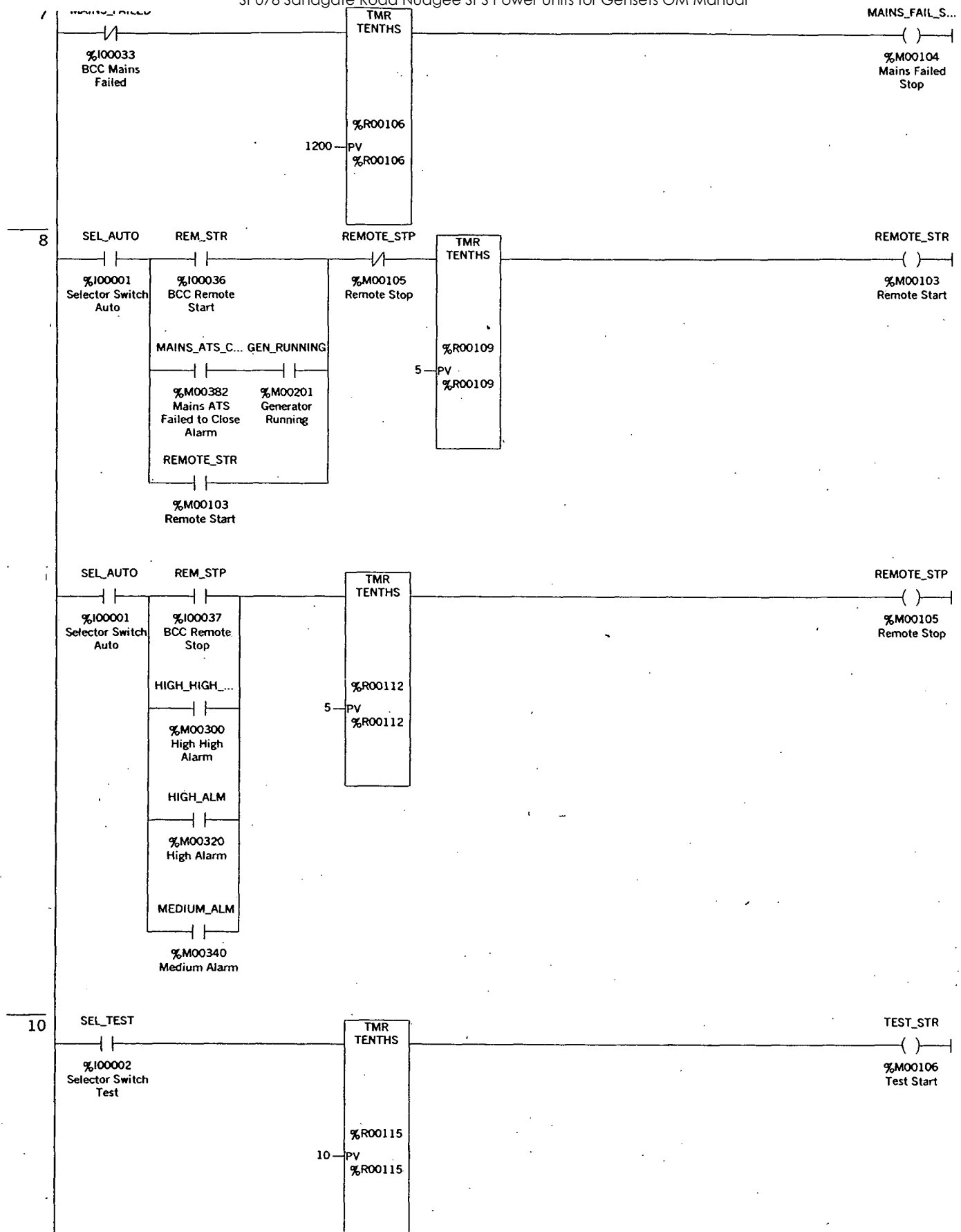
A:

MODI



Program: BCC\_4000\_4

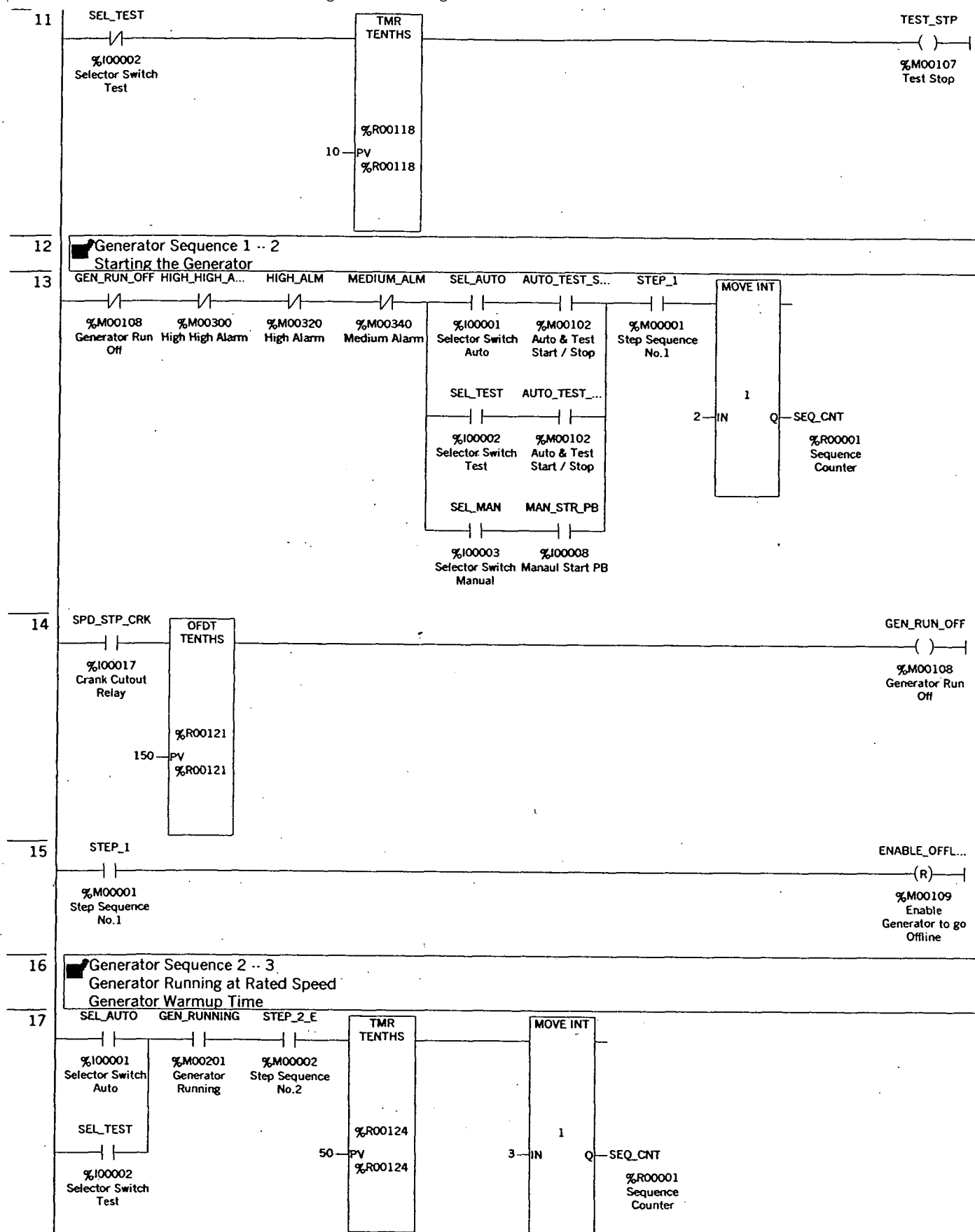
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Program: BCC\_4000\_4

A:

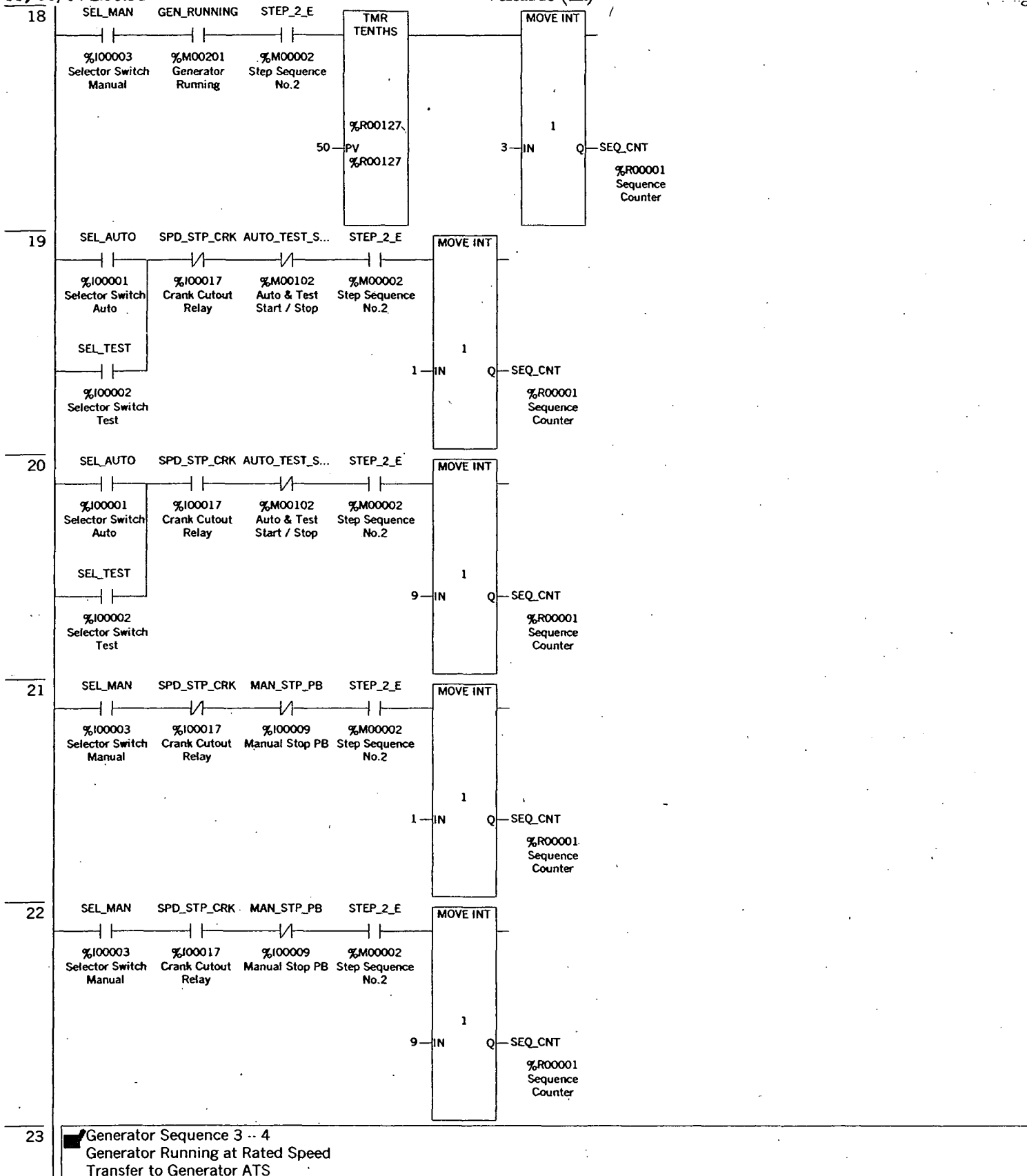
SI



Program: BCC\_4000\_4

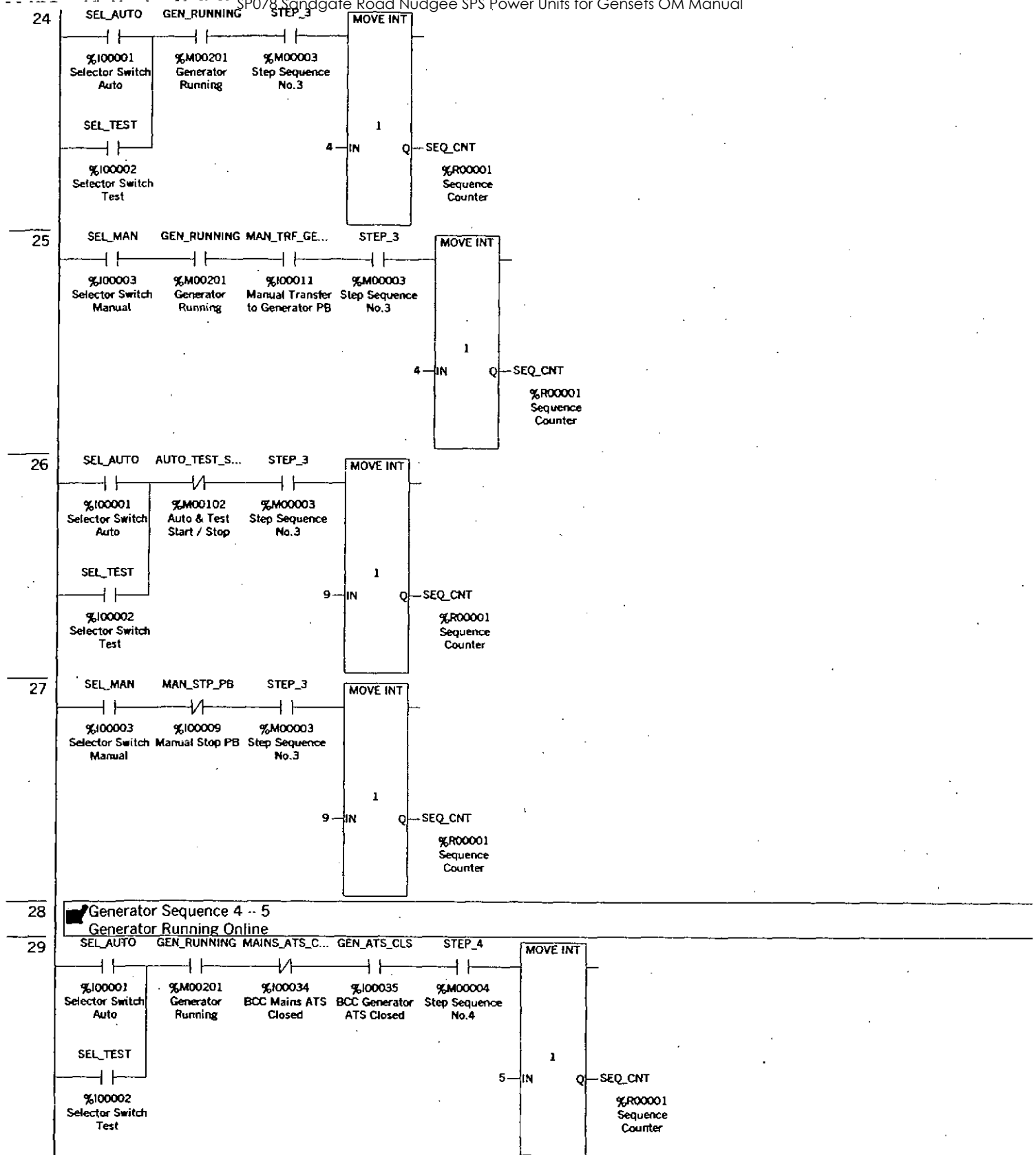
A:

S



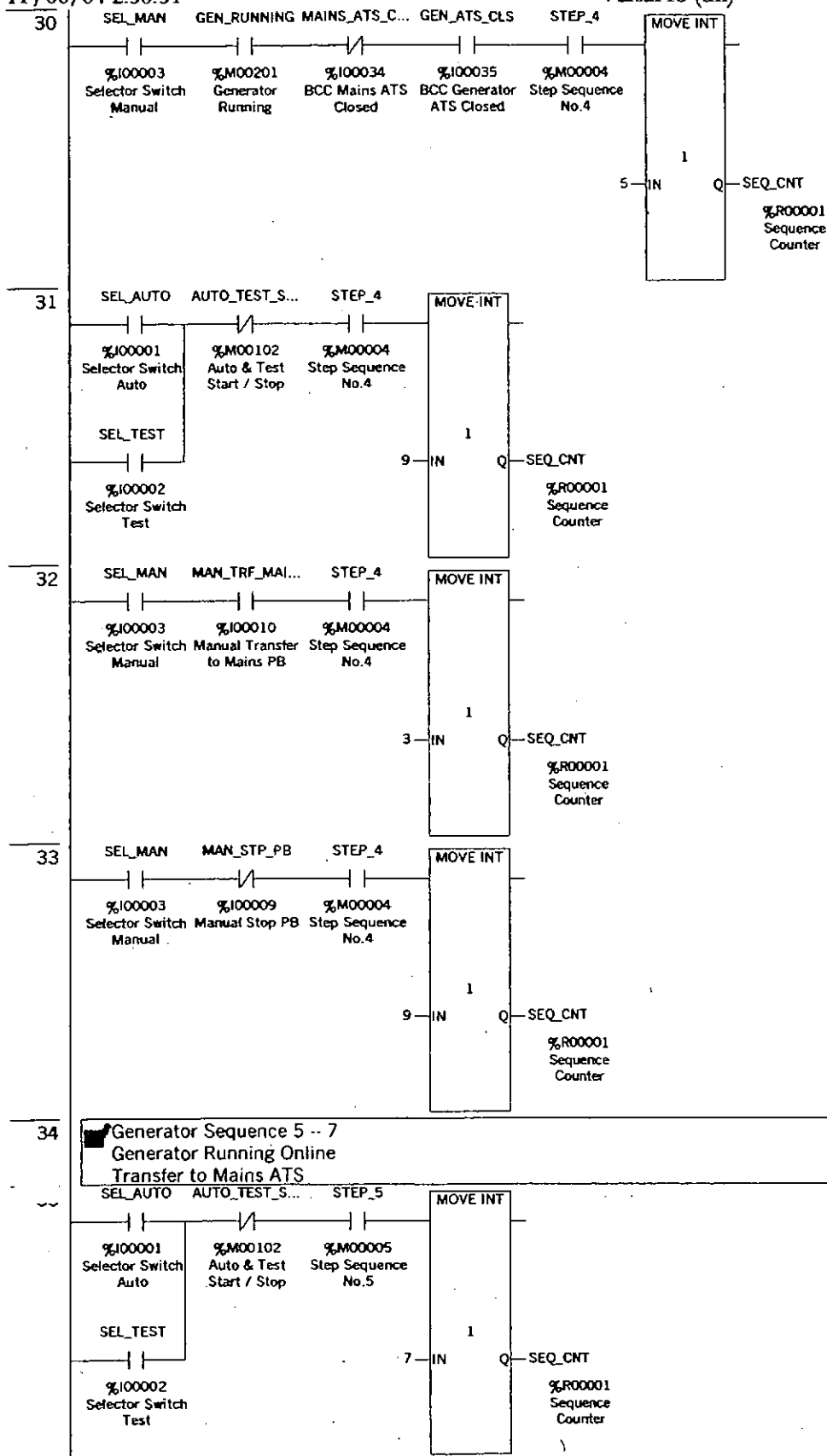
I m: BCC\_4000\_4

A:



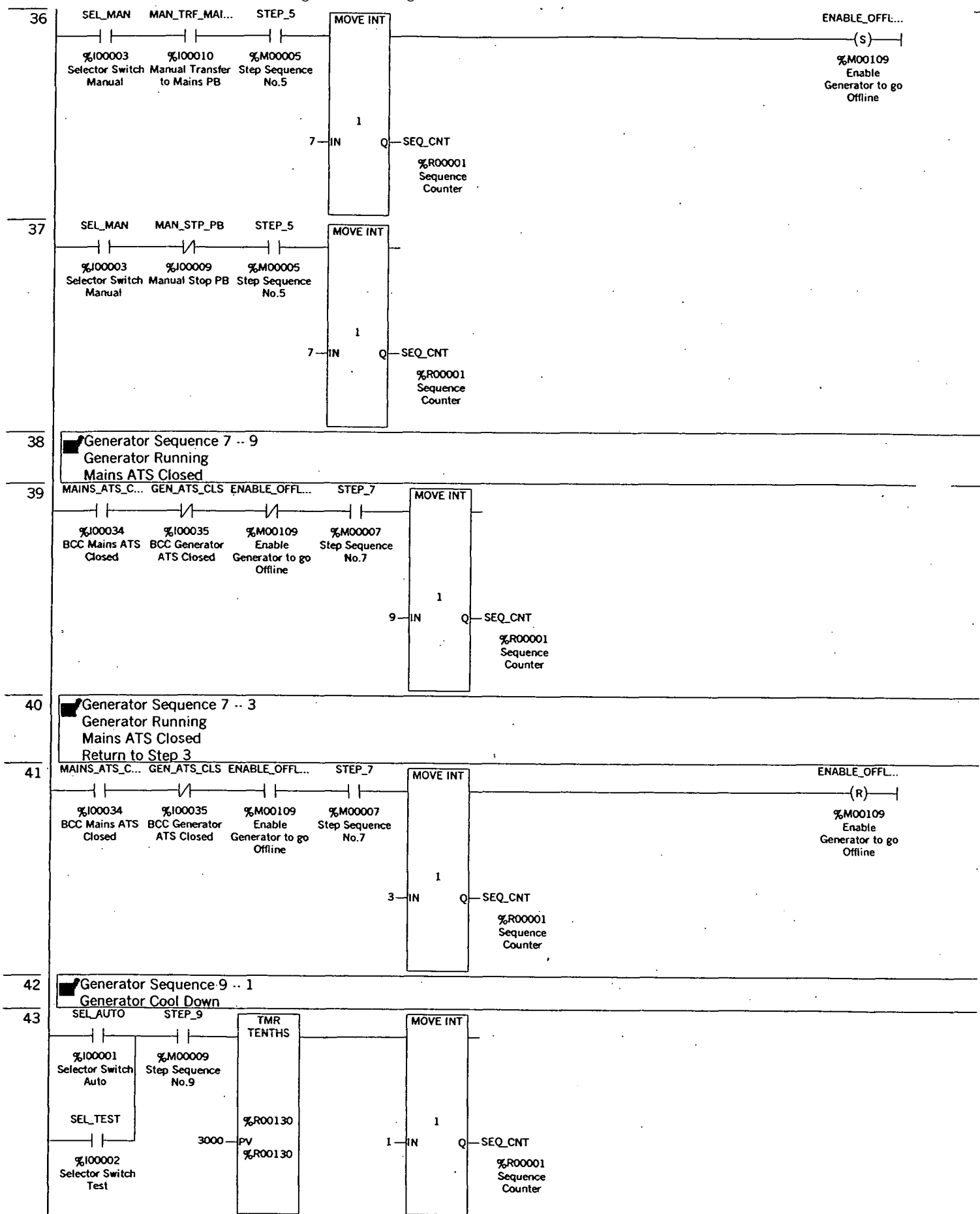
Program: BCC\_4000\_4

A:



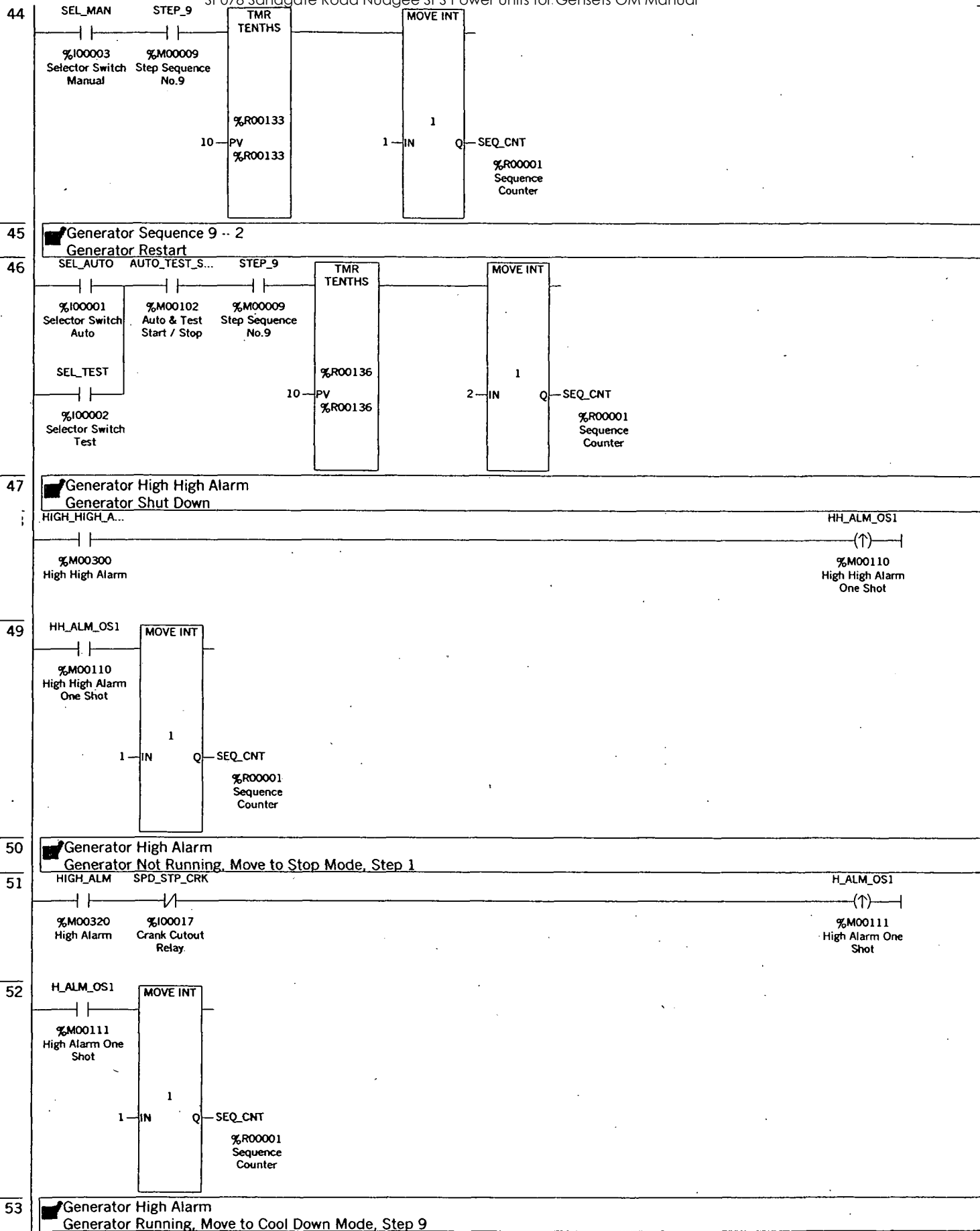
I um: BCC\_4000\_4

A:



Program: BCC\_4000\_4

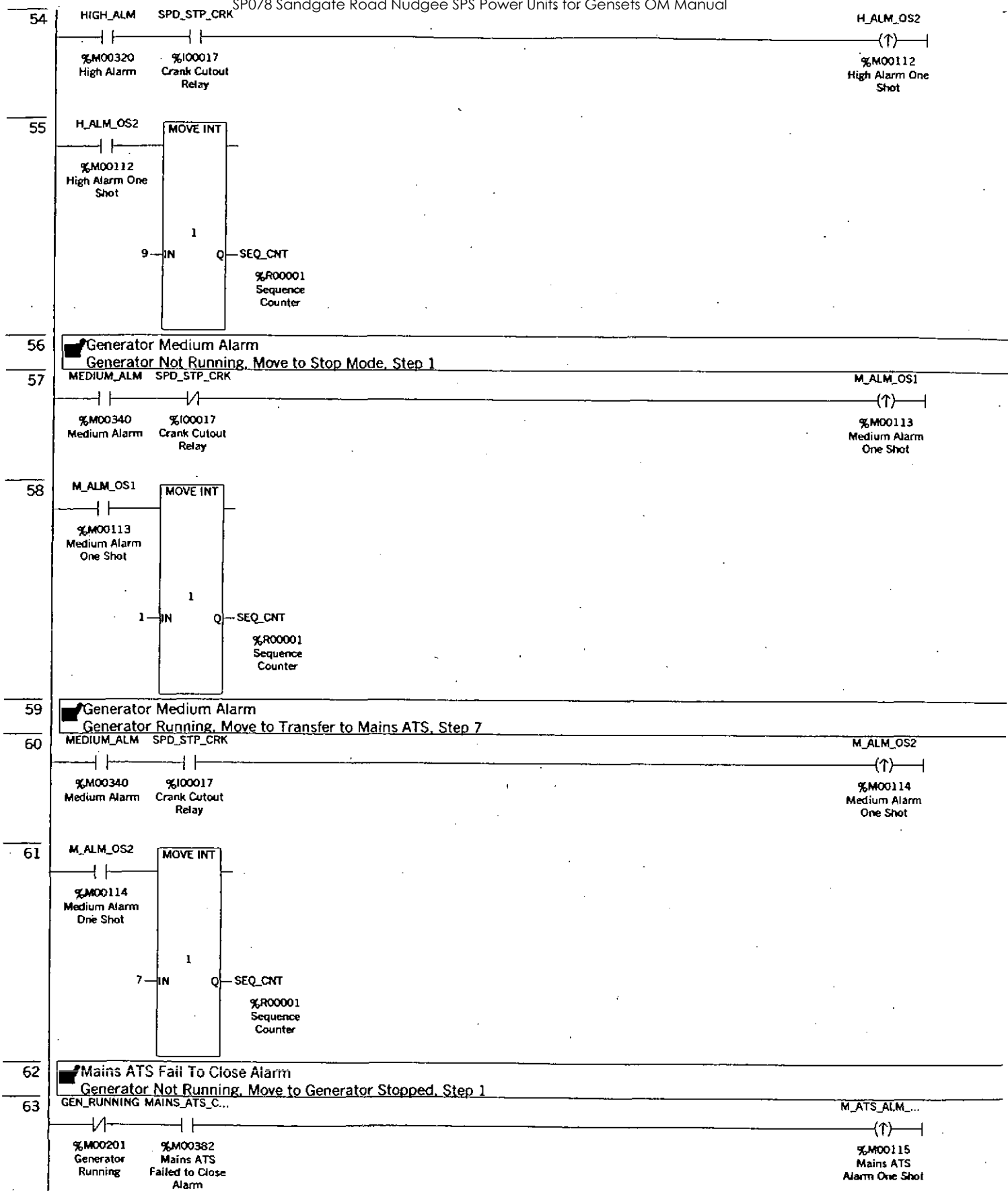
A:



P. m: BCC\_4000\_4

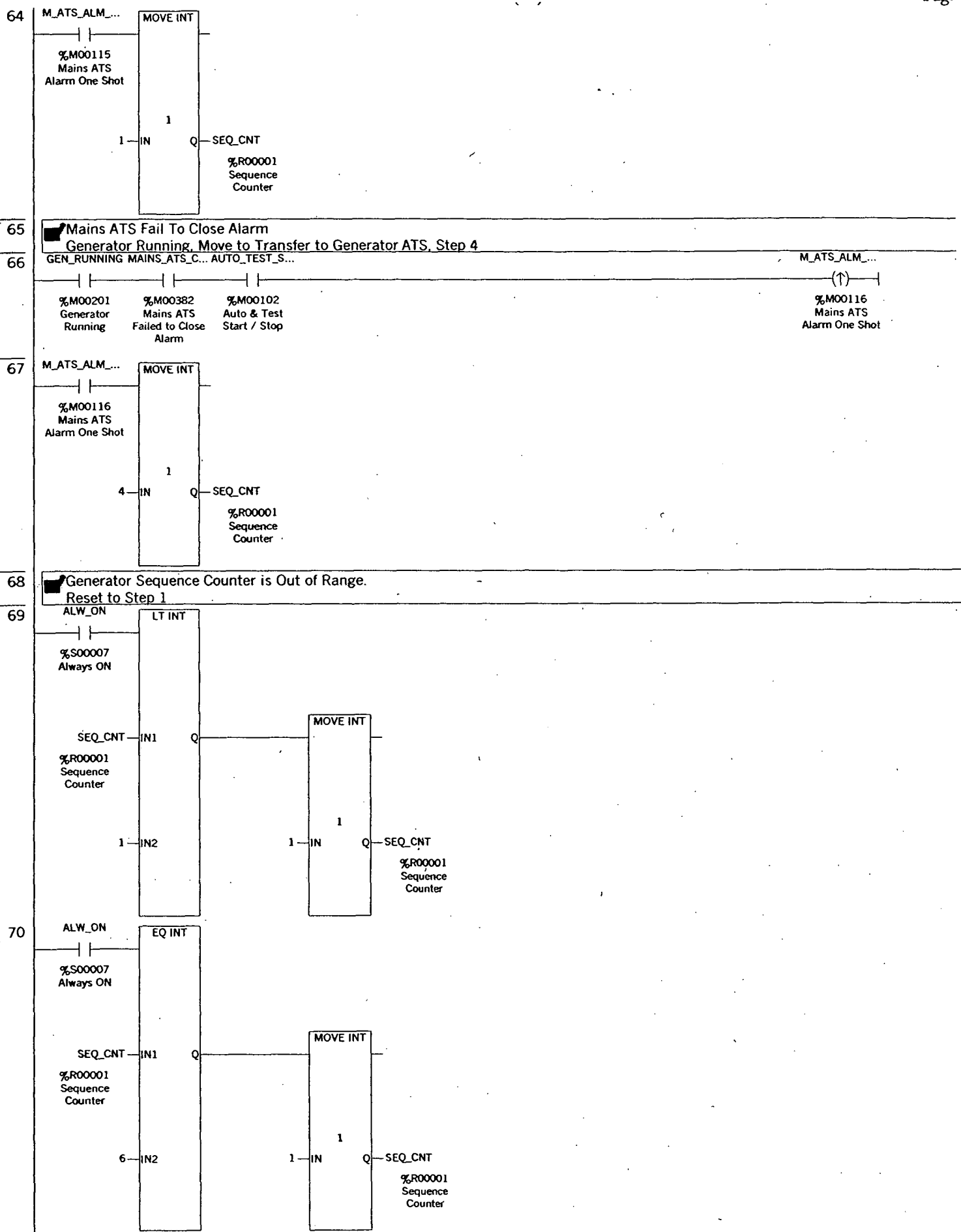
A:

S



Program: BCC\_4000\_4

A:



Pr n: BCC\_4000\_4

A:

SI

71

ALW\_ON

%S00007  
Always ON

EQ INT

SEQ\_CNT

%R00001  
Sequence  
Counter

IN1

8 IN2

Q

MOVE INT

1

1 IN

Q

SEQ\_CNT

%R00001  
Sequence  
Counter

72

ALW\_ON

%S00007  
Always ON

GT INT

SEQ\_CNT

%R00001  
Sequence  
Counter

IN1

9 IN2

Q

MOVE INT

1

1 IN

Q

SEQ\_CNT

%R00001  
Sequence  
Counter

Program: BCC\_4000\_4

A:

ε

1  Generator High High Alarms

2 EM\_STP\_ALM

HIGH\_HIGH\_A...

%M00301  
Emergency  
Stop Alarm

( )  
%M00300  
High High Alarm

MEN\_ALM

%M00302  
MEN Alarm

OIL\_P\_SD\_ALM

%M00303  
Low Oil  
Pressure  
Shutdown  
Alarm  
ENG\_T\_SD\_A...

%M00304  
High Engine  
Temperature  
Shutdown  
Alarm  
RAD\_WATER...

%M00305  
Low Radiator  
Water Level  
Alarm

SPD\_OVER\_A...

%M00306  
Over Speed  
Alarm

3  Generator High Alarms

4 SPD\_UNDER...

HIGH\_ALM

%M00321  
Under Speed  
Alarm

( )  
%M00320  
High Alarm

VOLTS\_UNDE...

%M00322  
Alternator  
Voltage Under  
Alarm

VOLTS\_OVER...

%M00323  
Alternator  
Voltage Over  
Alarm

GEN\_CB\_TRI...

%M00324  
Generator CB  
Tripped Alarm

ALT\_TEMP\_A...

%M00325  
Alternator High  
Temperature  
Alarm

5  Generator Medium Alarms

P: n: BCC\_4000\_4

A:

ALA

MEDIUM\_ALM

( )

%M00340  
Medium Alarm

%M00341  
Fuel Empty  
Alarm

FAIL\_TO\_STR...

%M00342  
Fail to Start  
Alarm

MAINS\_ATS\_...

%M00381  
Mains ATS  
Failed to Open  
Alarm

GEN\_ATS\_CL...

%M00384  
Generator ATS  
Failed to Close  
Alarm

7

Generator Low Alarms

8

OIL\_P\_W\_ALM

LOW\_ALM

%M00361  
Low Oil  
Pressure  
Warning Alarm

( )  
%M00360  
Low Alarm

ENG\_T\_W\_ALM

%M00362  
High Engine  
Temperature  
Warning Alarm

FUEL\_LEV\_L...

%M00363  
Low Fuel Level  
Alarm

BAT\_CHG\_AC...

%M00364  
Battery Charger  
AC Alarm

BAT\_CONT\_L...

%M00365  
Control Battery  
Charger Low  
Voltage Alarm

BAT\_STR\_LO...

%M00366  
Start Battery  
Charger Low  
Voltage Alarm

MAINS\_ATS\_...

%M00382  
Mains ATS  
Failed to Close  
Alarm

GEN\_ATS\_OP...

%M00383  
Generator ATS  
Failed to Open  
Alarm

9

Generator Emergency Stop Alarm

EM\_STOP\_PB

EM\_STP\_ALM

%I00004  
Emergency Stop  
PB

( )  
%M00301  
Emergency Stop  
Alarm

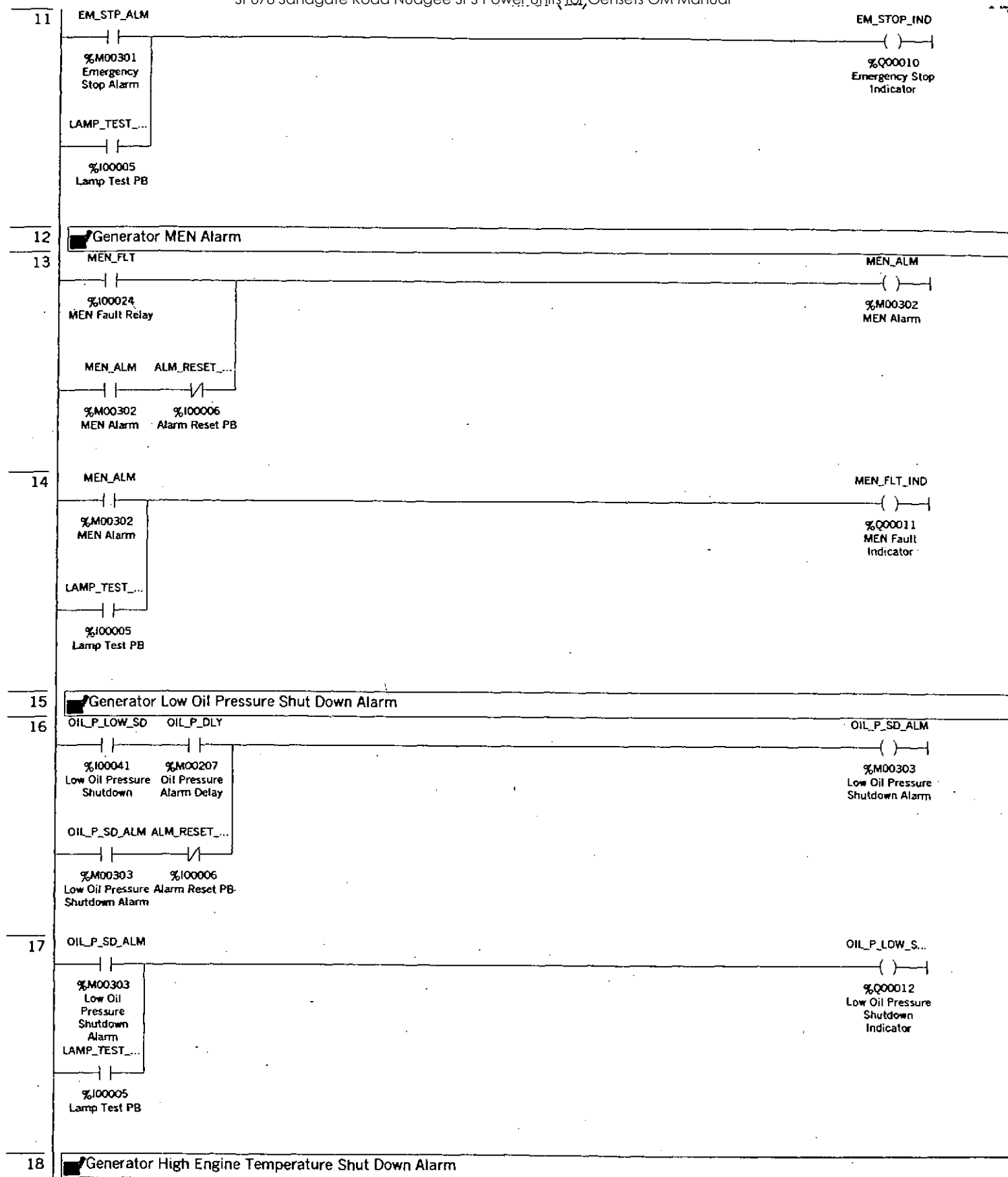
EM\_STP\_ALM ALM\_RESET\_...

%M00301    %I00006  
Emergency Stop Alarm Reset PB  
Alarm

Pr    n: BCC\_4000\_4

A:

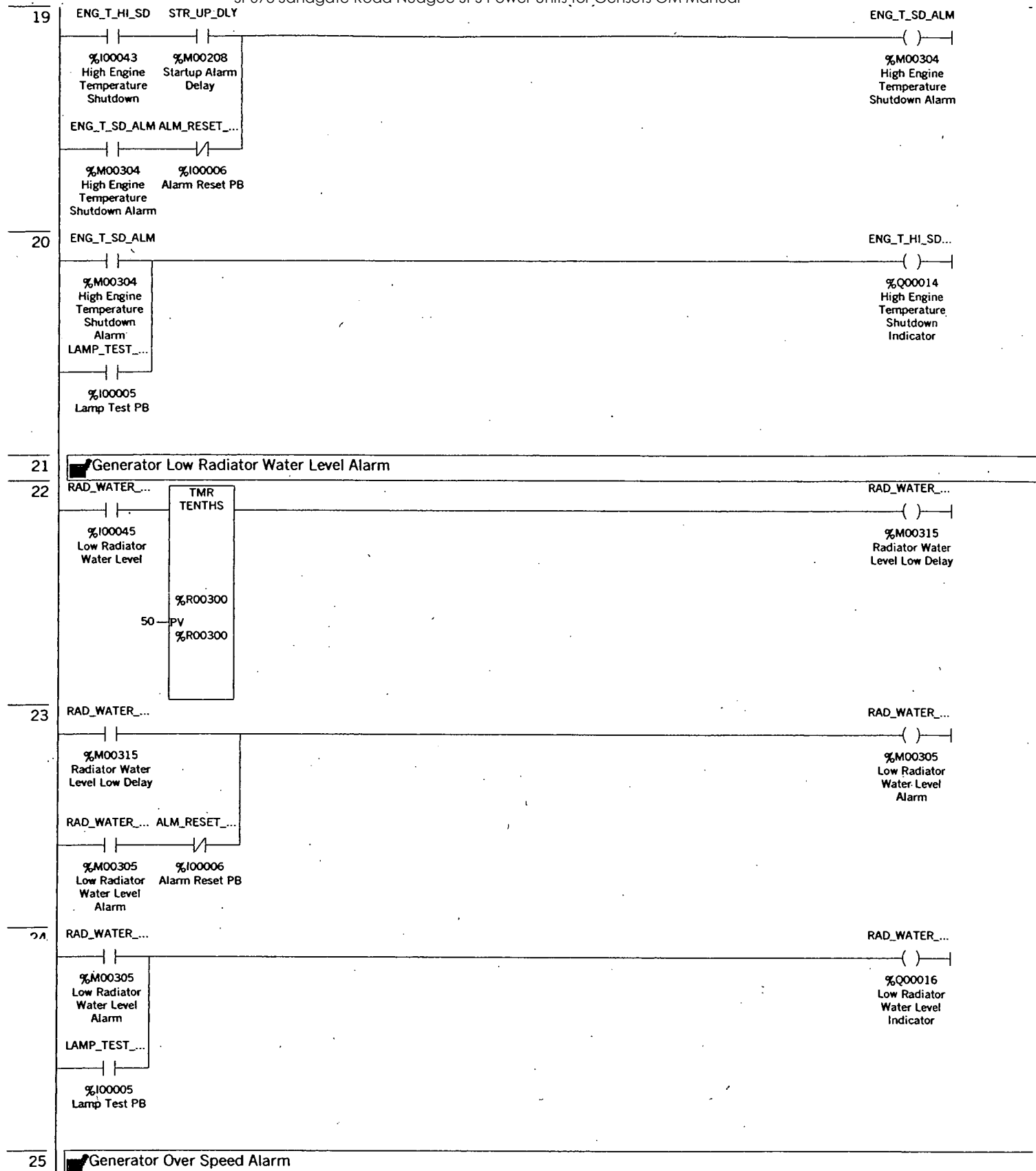
ALA



Program: BCC\_4000\_4

A:

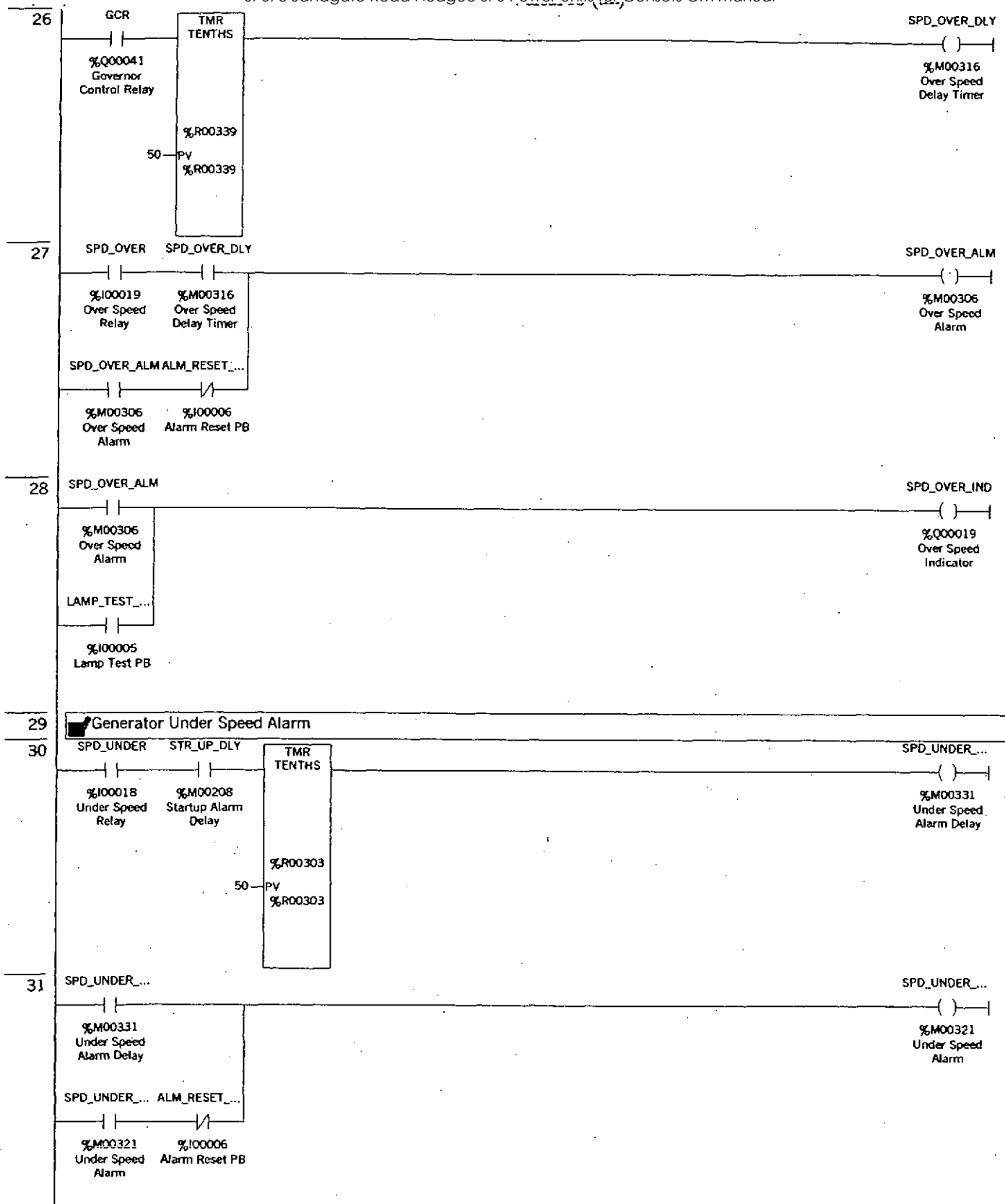
JLA



F um: BCC\_4000\_4

A:

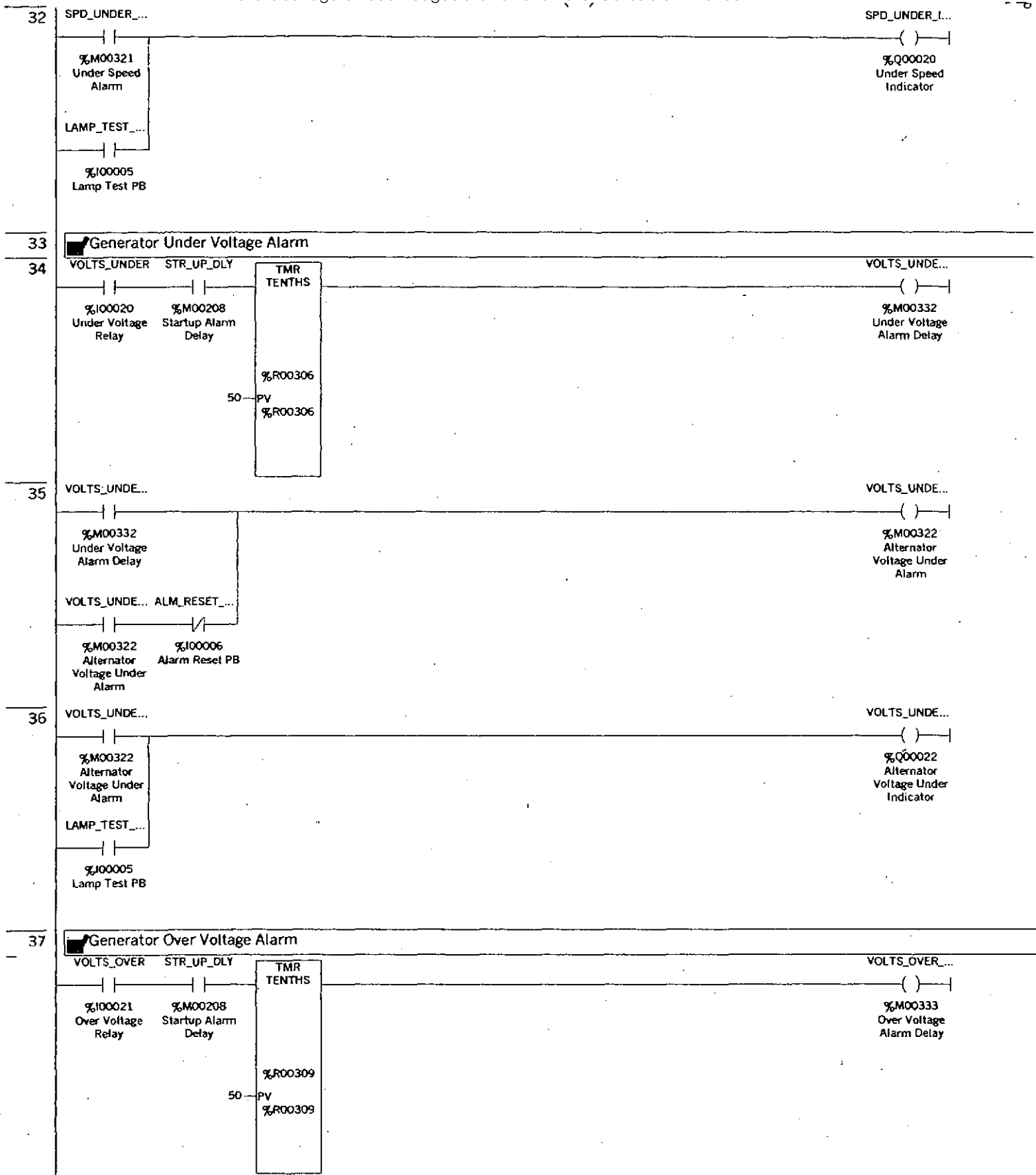
ALA



Program: BCC\_4000\_4

A:

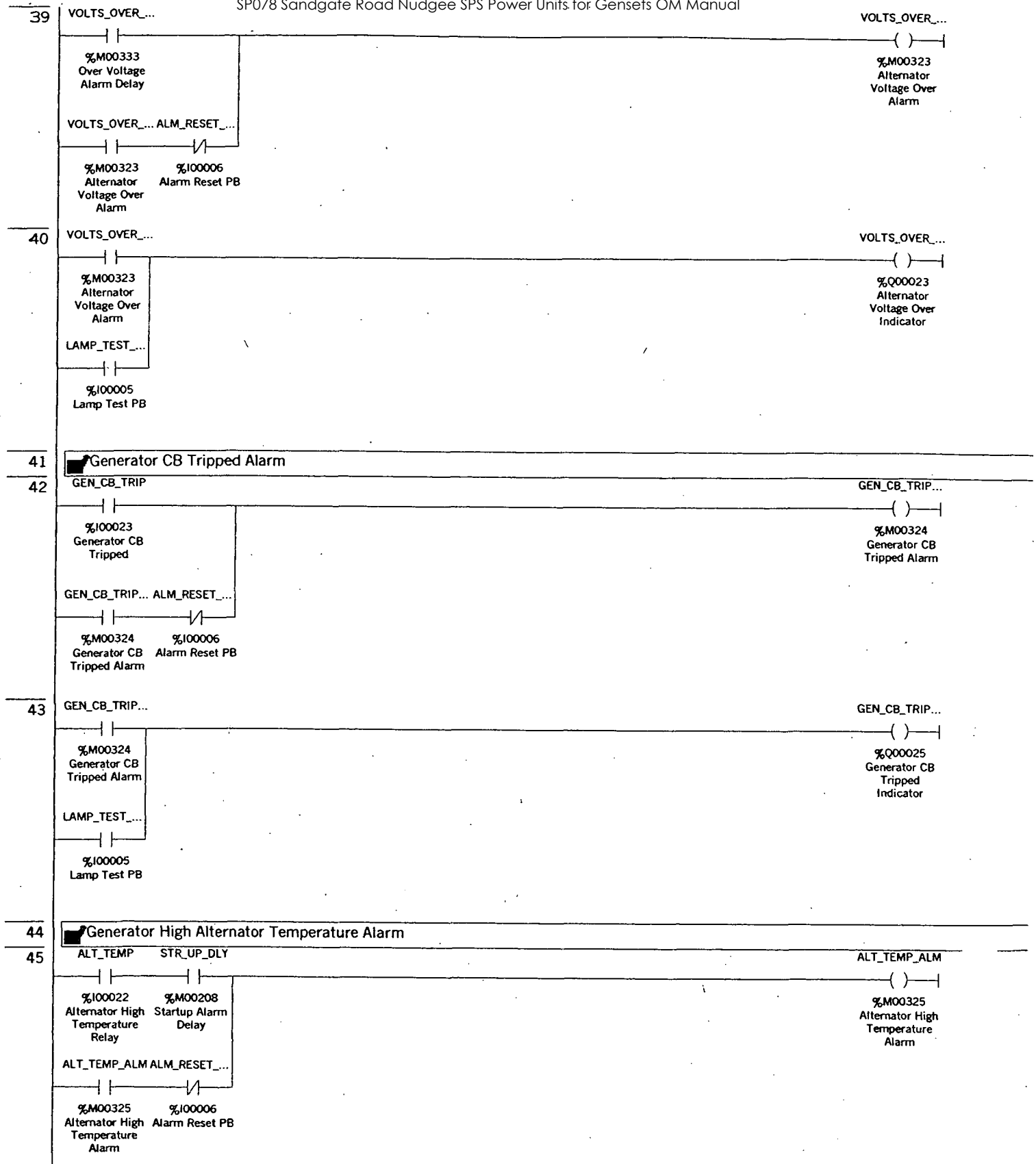
ALA



Pr a: BCC\_4000\_4

A:

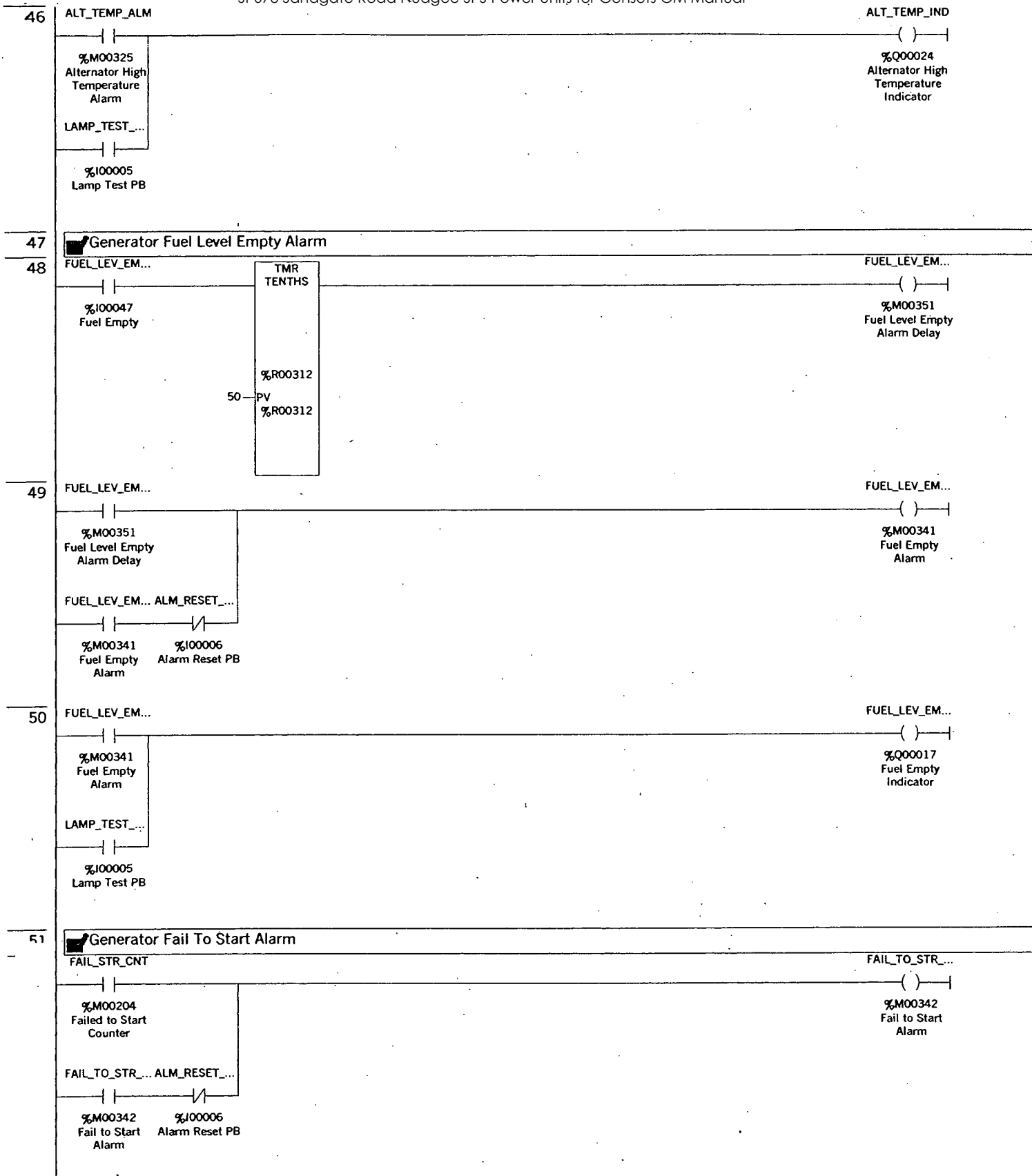
ALAI



Program: BCC\_4000\_4

A:

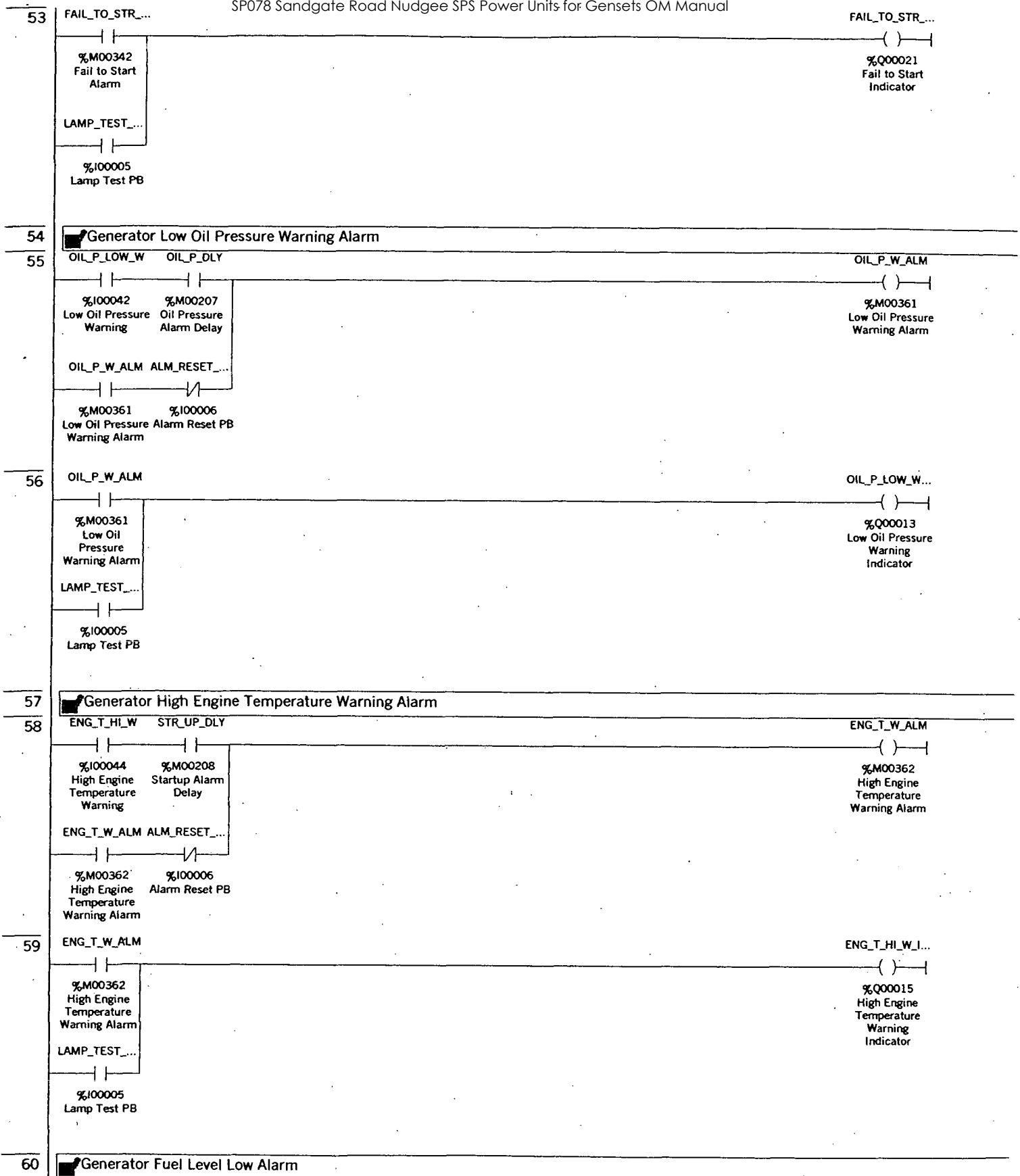
ALA



P m: BCC\_4000\_4

A:

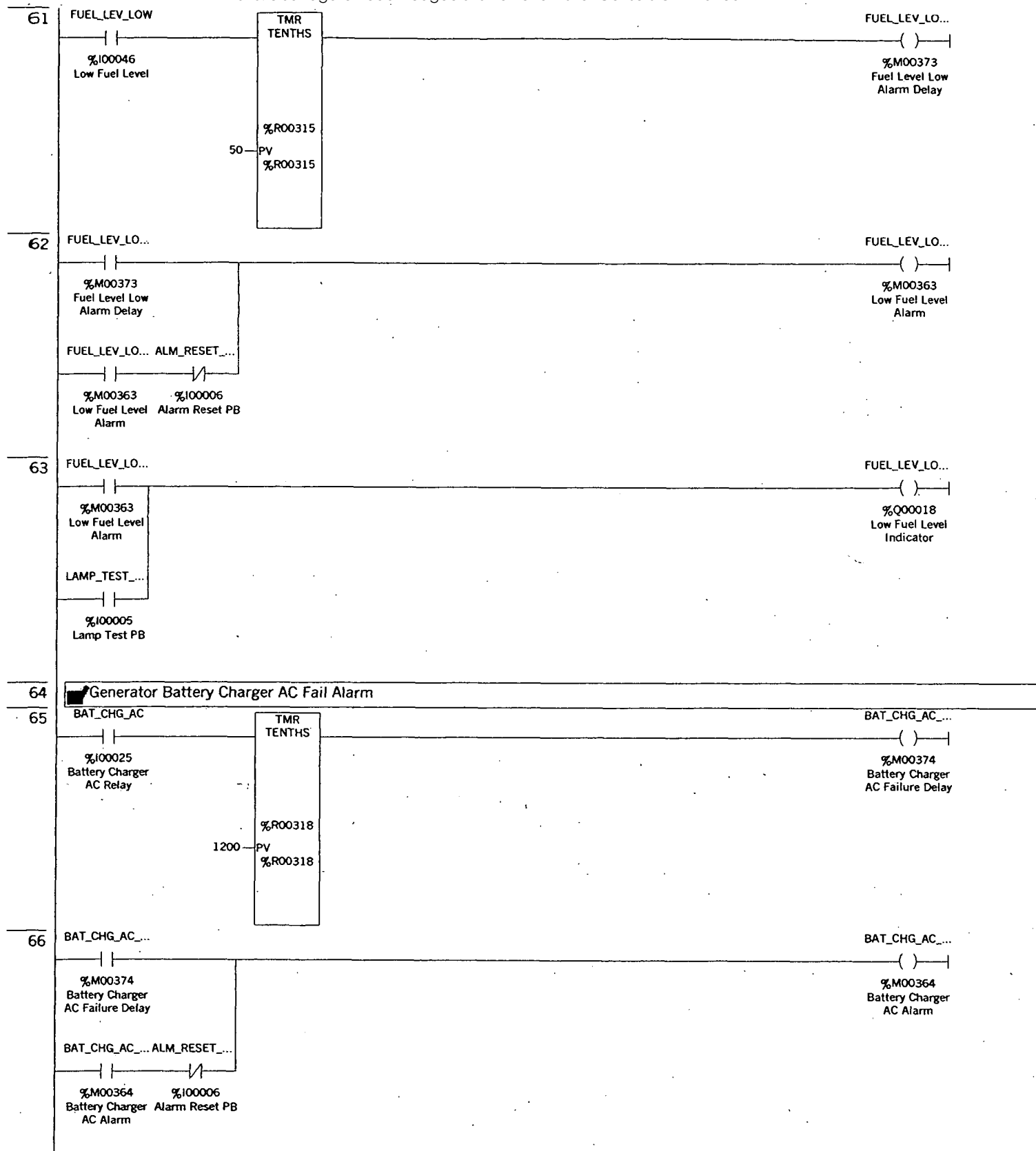
ALA



Program: BCC\_4000\_4

A:

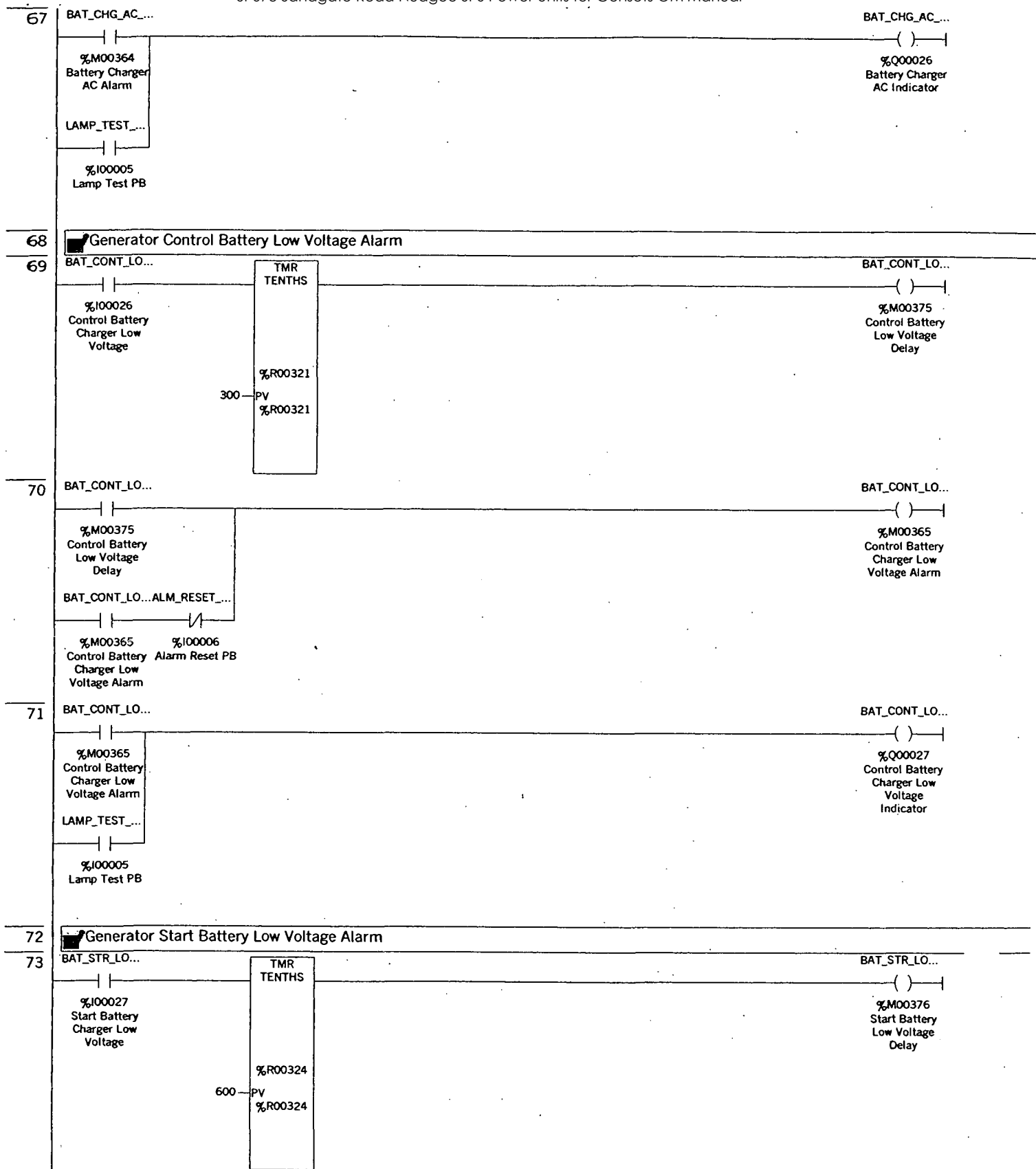
ALA



P m: BCC\_4000\_4

A:

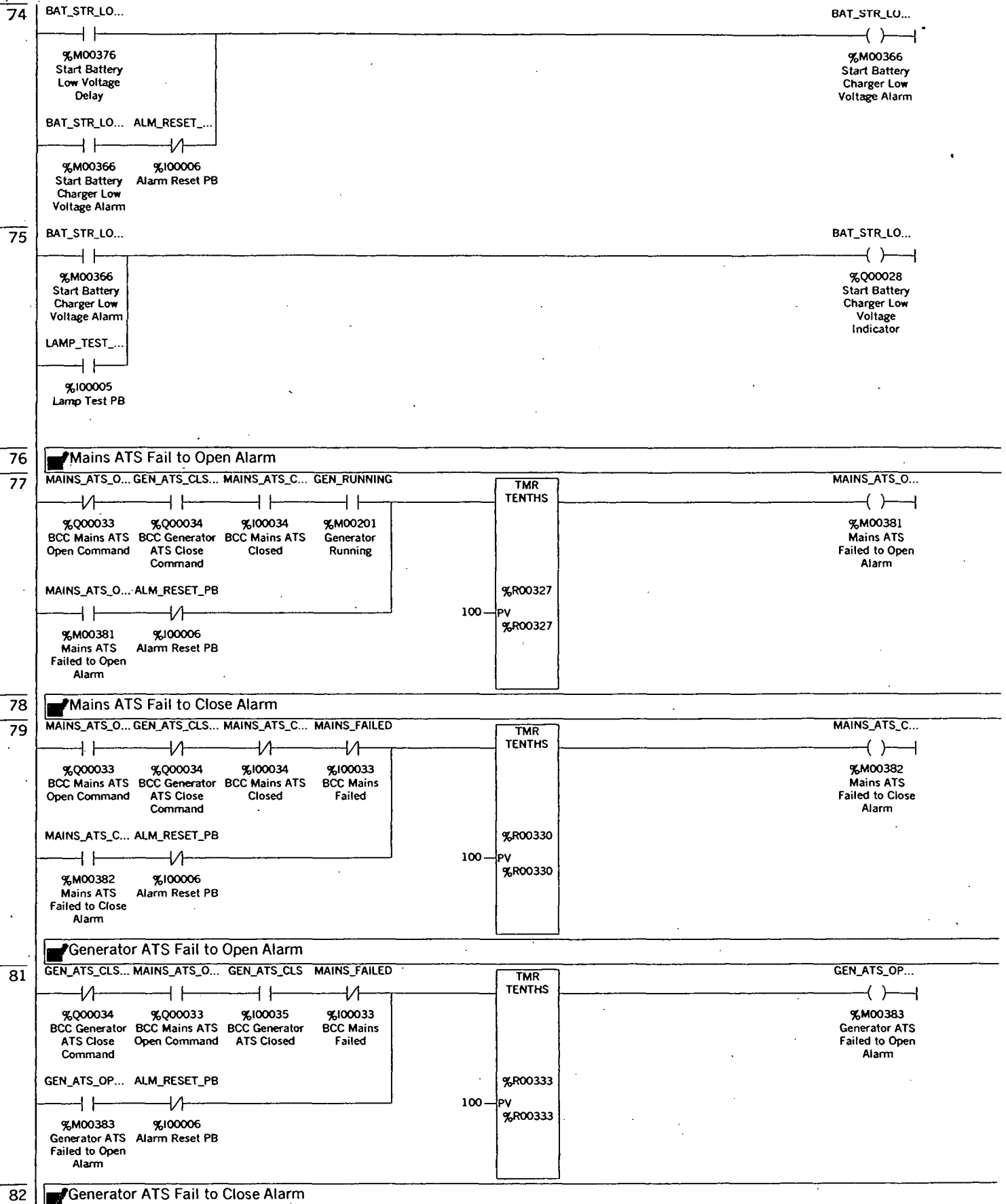
ALA



Program: BCC\_4000\_4

A:

ALA

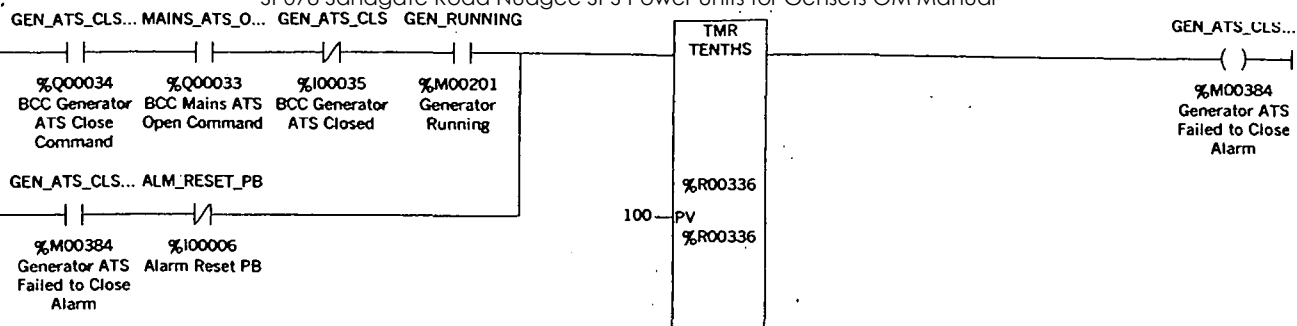


1 um: BCC\_4000\_4

A:

AL

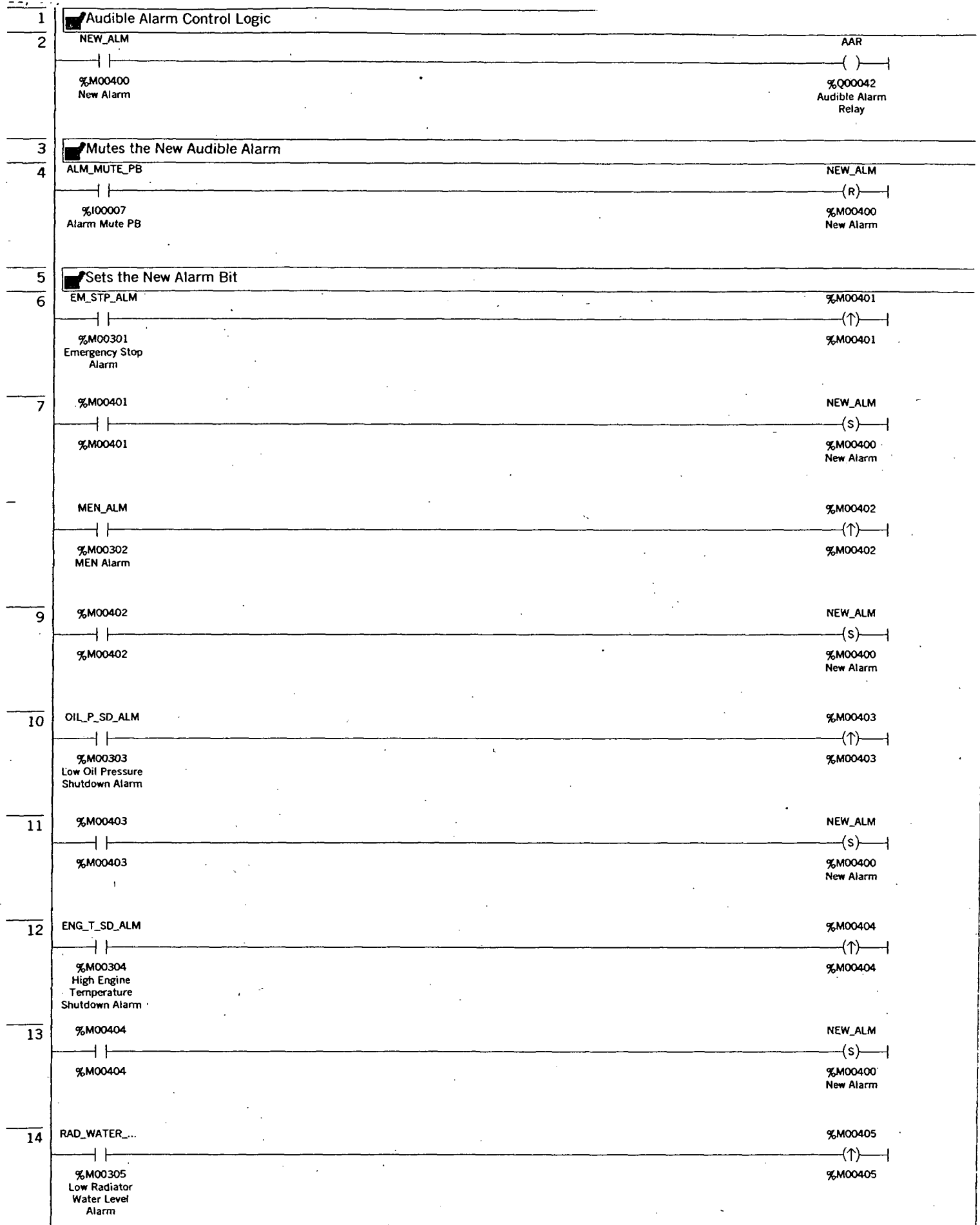
83



Program: BCC\_4000\_4

A:

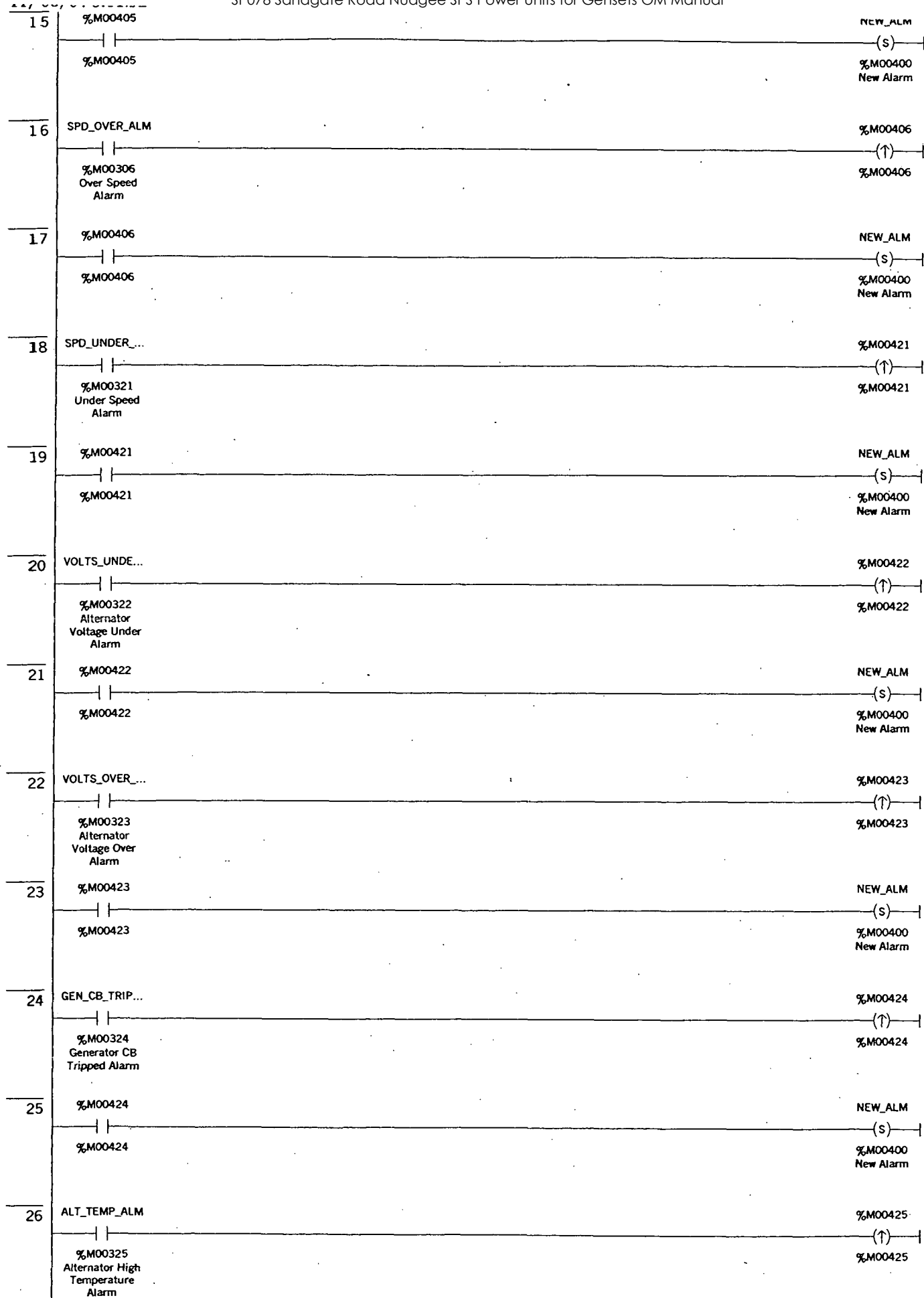
AL



F m: BCC\_4000\_4

A:

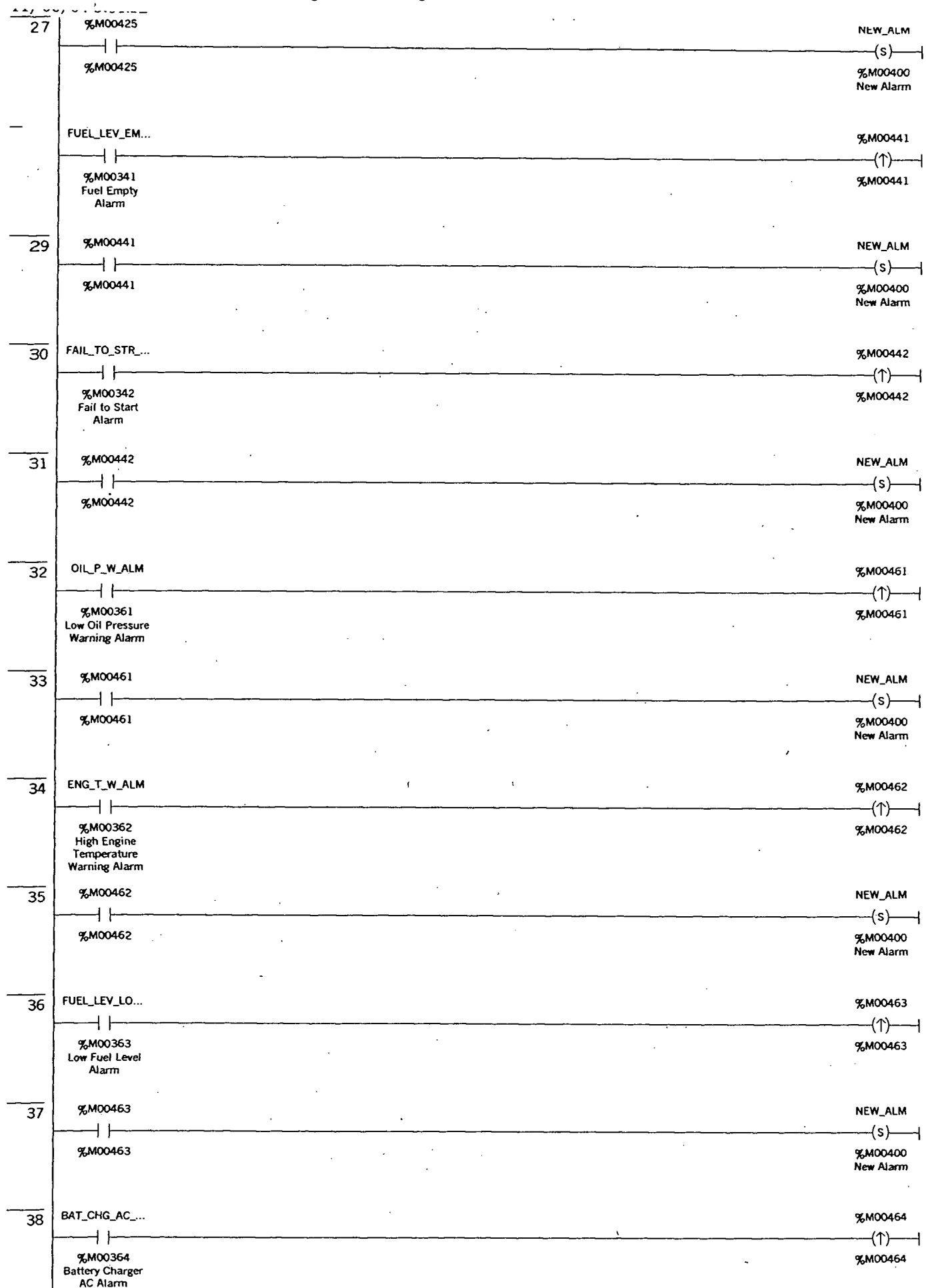
AUD\_



Program: BCC\_4000\_4

A:

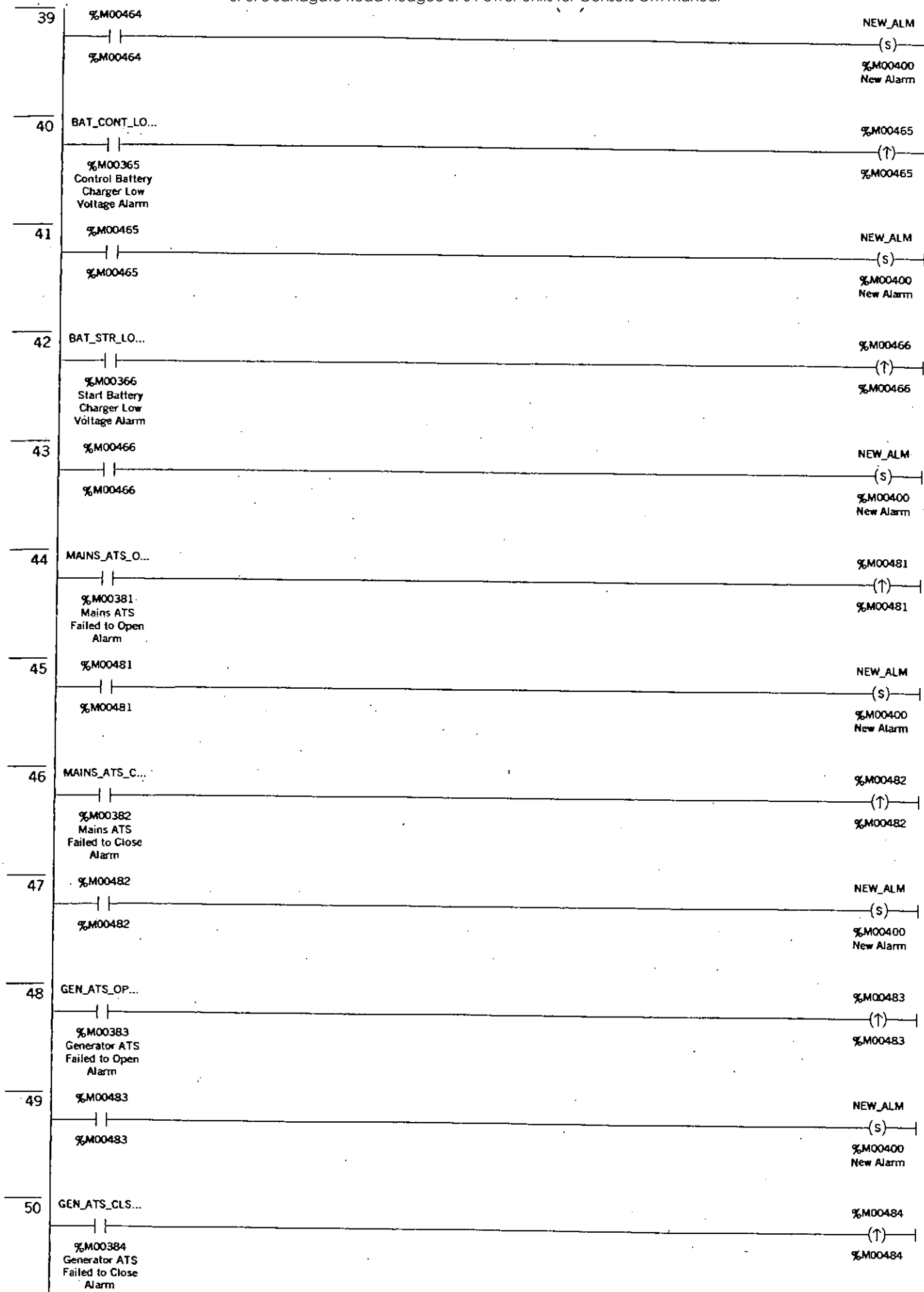
JD\_



1 am: BCC\_4000\_4

A:

AUD\_



Program: BCC\_4000\_4

A:

D\_A

51

%M00484

%M00484

NEW\_ALM

(S)

%M00400  
New Alarm

I m: BCC\_4000\_4

A:

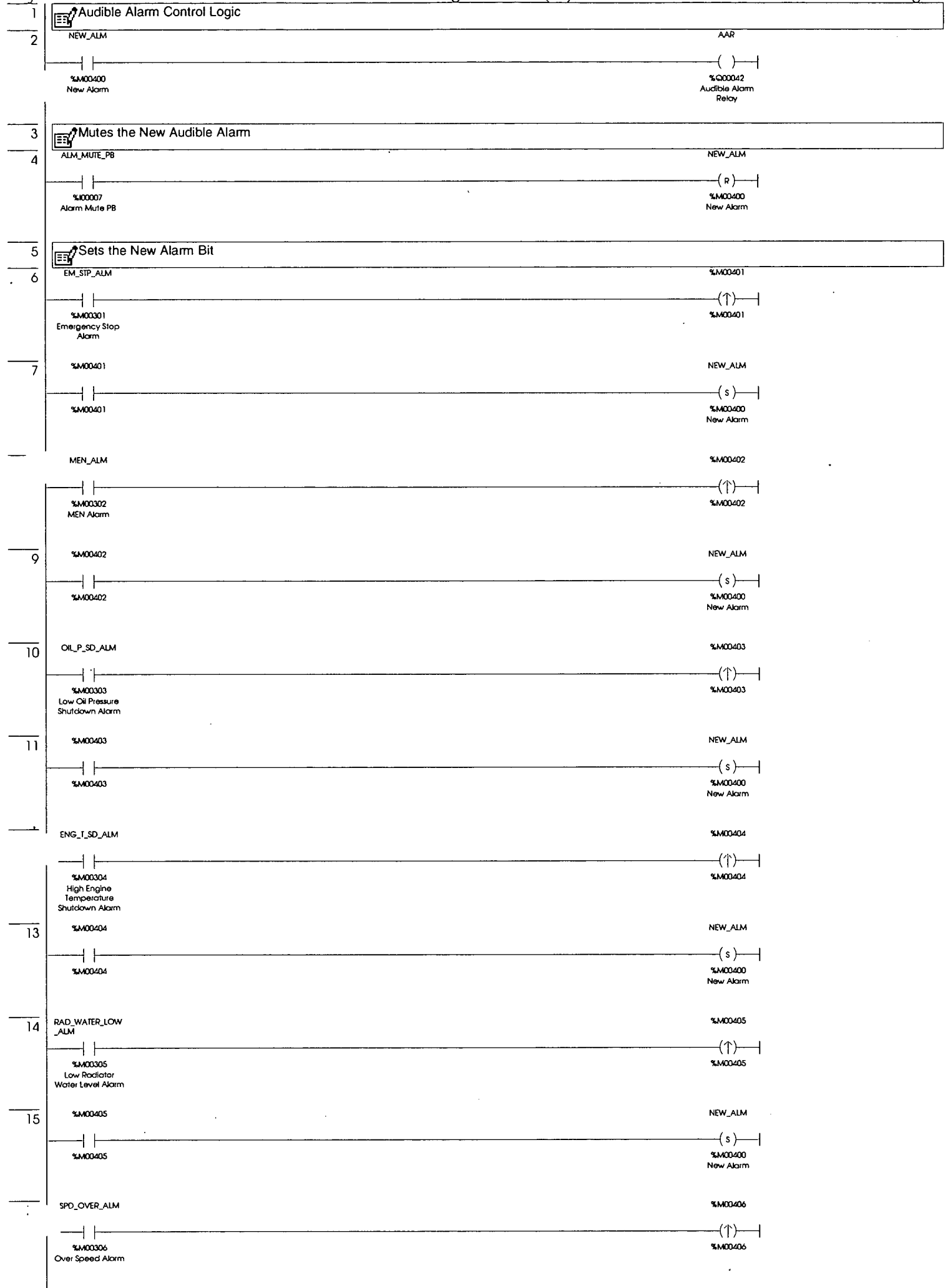
AUD\_1



# NTB Design

Folder Name..... BCC\_4000\_2  
Nickname..... C4000\_2  
Location..... C:\Program Files\GE Fanuc Automation\VersaPro  
                  \Project\BCC\_4000\_2  
Created..... 27-Jun-03, 16:36:03  
Modified..... 03-Jul-03, 18:02:02  
Description..... BCC, Standby Generator, 4000

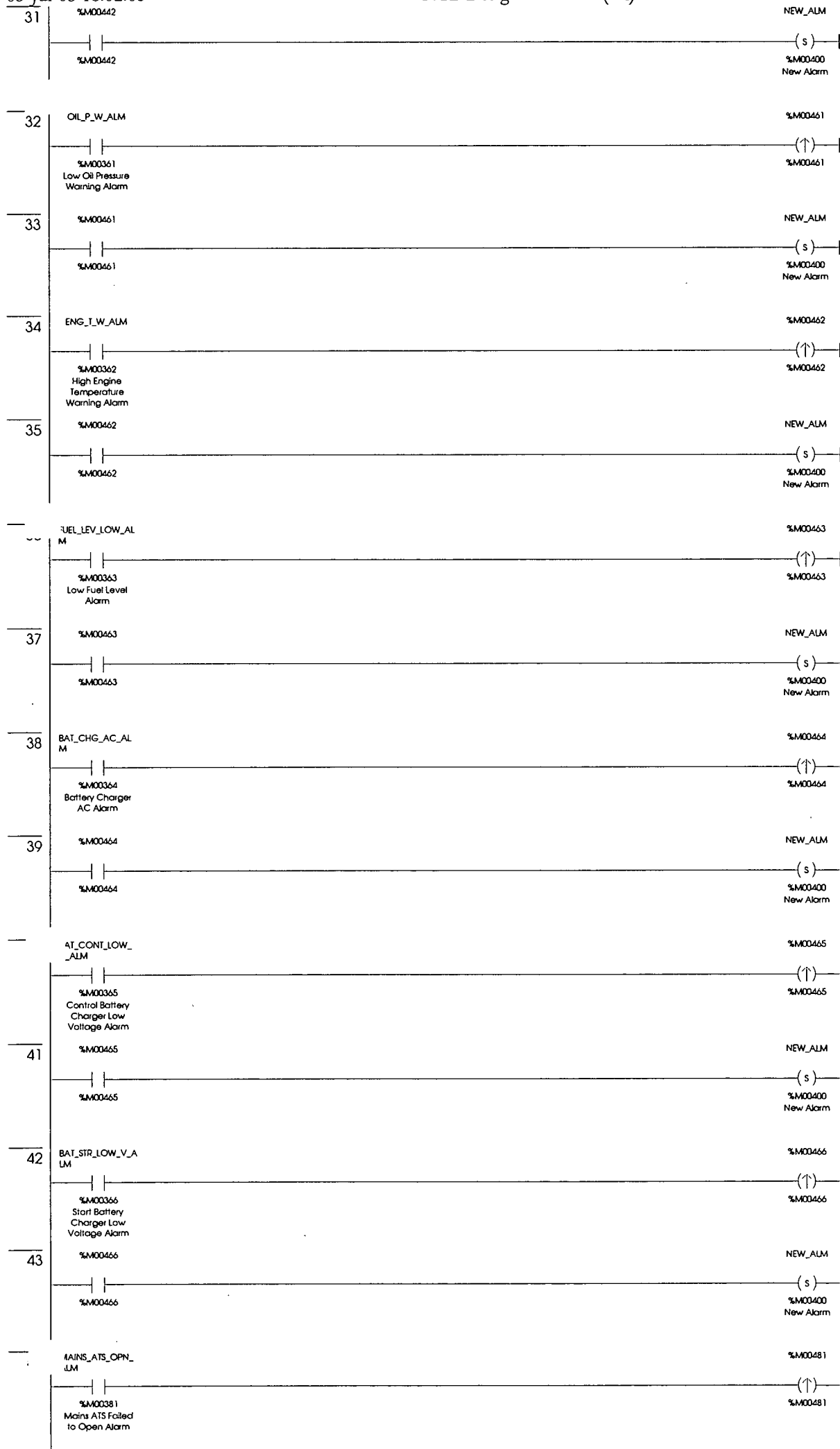
Block Name:..... AUD\_ALM.blk  
Description:..... Control Logic for the Audiable Alarm Logic.  
Block Type:..... Ladder



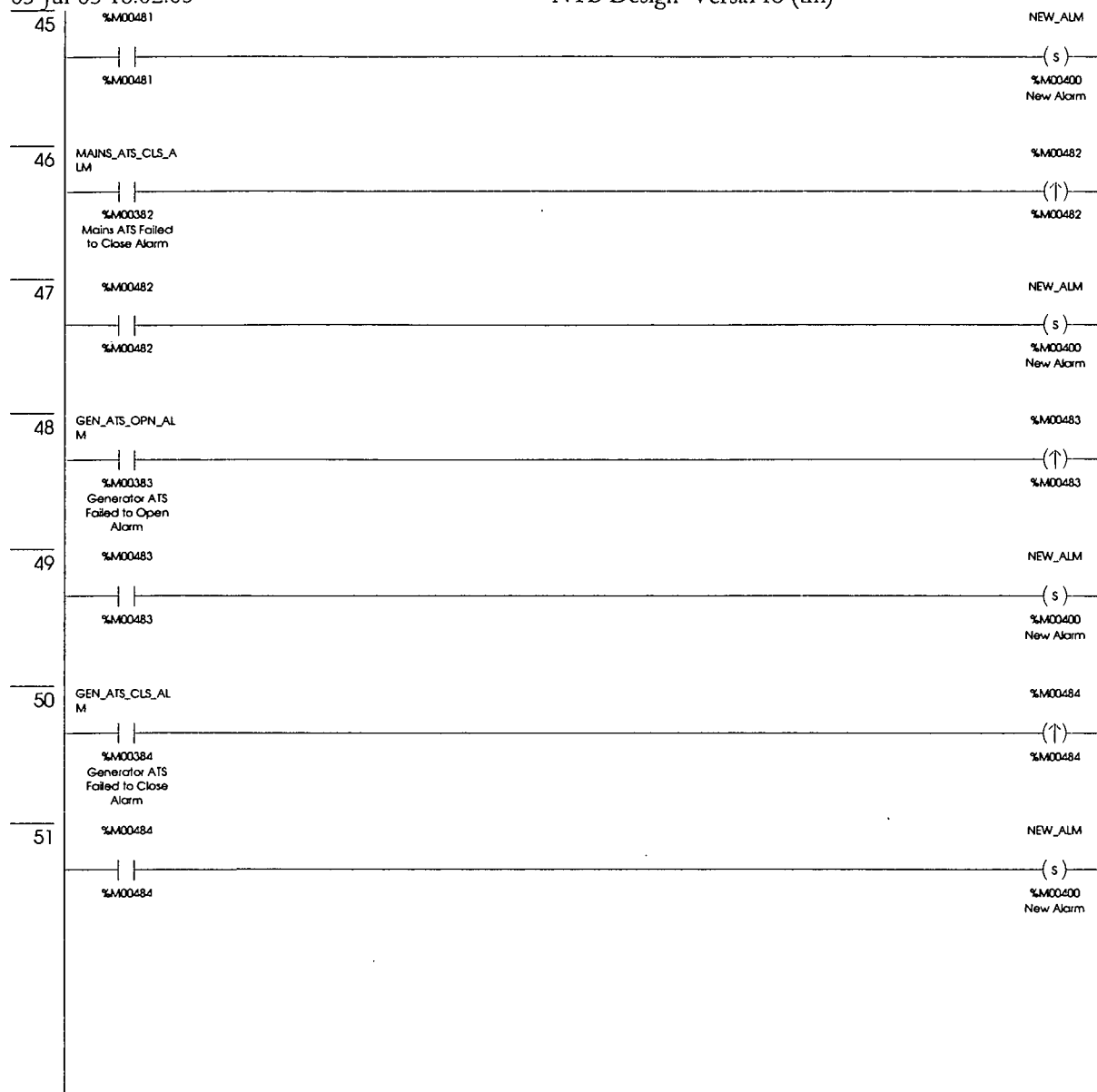
03-Jul-03 18:02:05

|    |                    |                      |
|----|--------------------|----------------------|
| 17 | %M00406            | NEW_ALM              |
|    | (s)                | %M00400<br>New Alarm |
| 18 | SPD_UNDER_ALM      | %M00421              |
|    | (↑)                | %M00421              |
| 19 | %M00421            | NEW_ALM              |
|    | (s)                | %M00400<br>New Alarm |
| 20 | VOLTS_UNDER_ALM    | %M00422              |
|    | (↑)                | %M00422              |
| 21 | %M00422            | NEW_ALM              |
|    | (s)                | %M00400<br>New Alarm |
| 22 | VOLTS_OVER_ALM     | %M00423              |
|    | (↑)                | %M00423              |
| 23 | %M00423            | NEW_ALM              |
|    | (s)                | %M00400<br>New Alarm |
| 24 | GEN_CB_TRIP_ALM    | %M00424              |
|    | (↑)                | %M00424              |
| 25 | %M00424            | NEW_ALM              |
|    | (s)                | %M00400<br>New Alarm |
| 26 | ALT_TEMP_ALM       | %M00425              |
|    | (↑)                | %M00425              |
| 27 | %M00425            | NEW_ALM              |
|    | (s)                | %M00400<br>New Alarm |
| 28 | FUEL_LEV_EMPTY_ALM | %M00441              |
|    | (↑)                | %M00441              |
| 29 | %M00441            | NEW_ALM              |
|    | (s)                | %M00400<br>New Alarm |
| 30 | FAIL_TO_STR_ALM    | %M00442              |
|    | (↑)                | %M00442              |

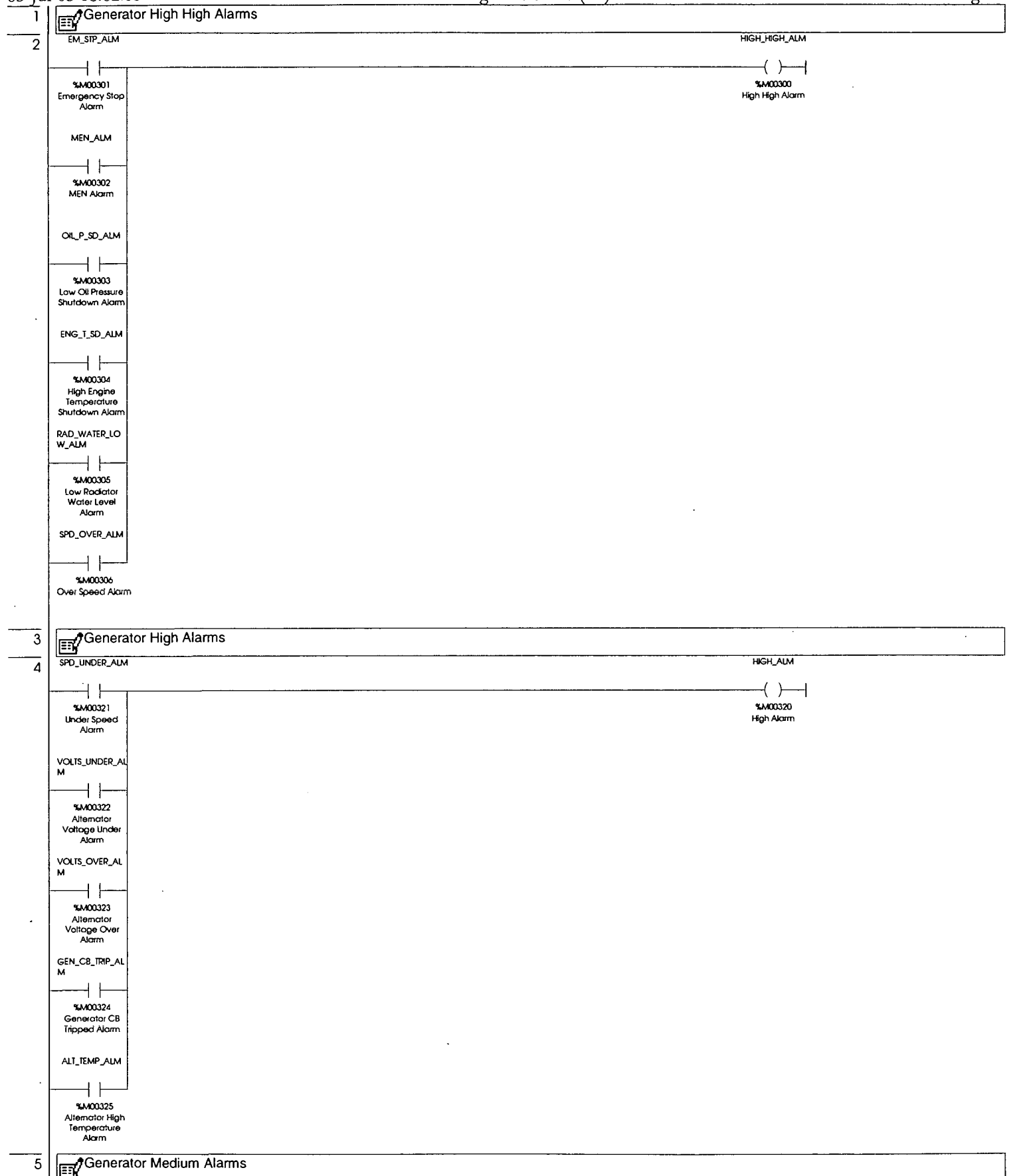
03-Jul-03 18:02:05



03-Jul-03 18:02:05



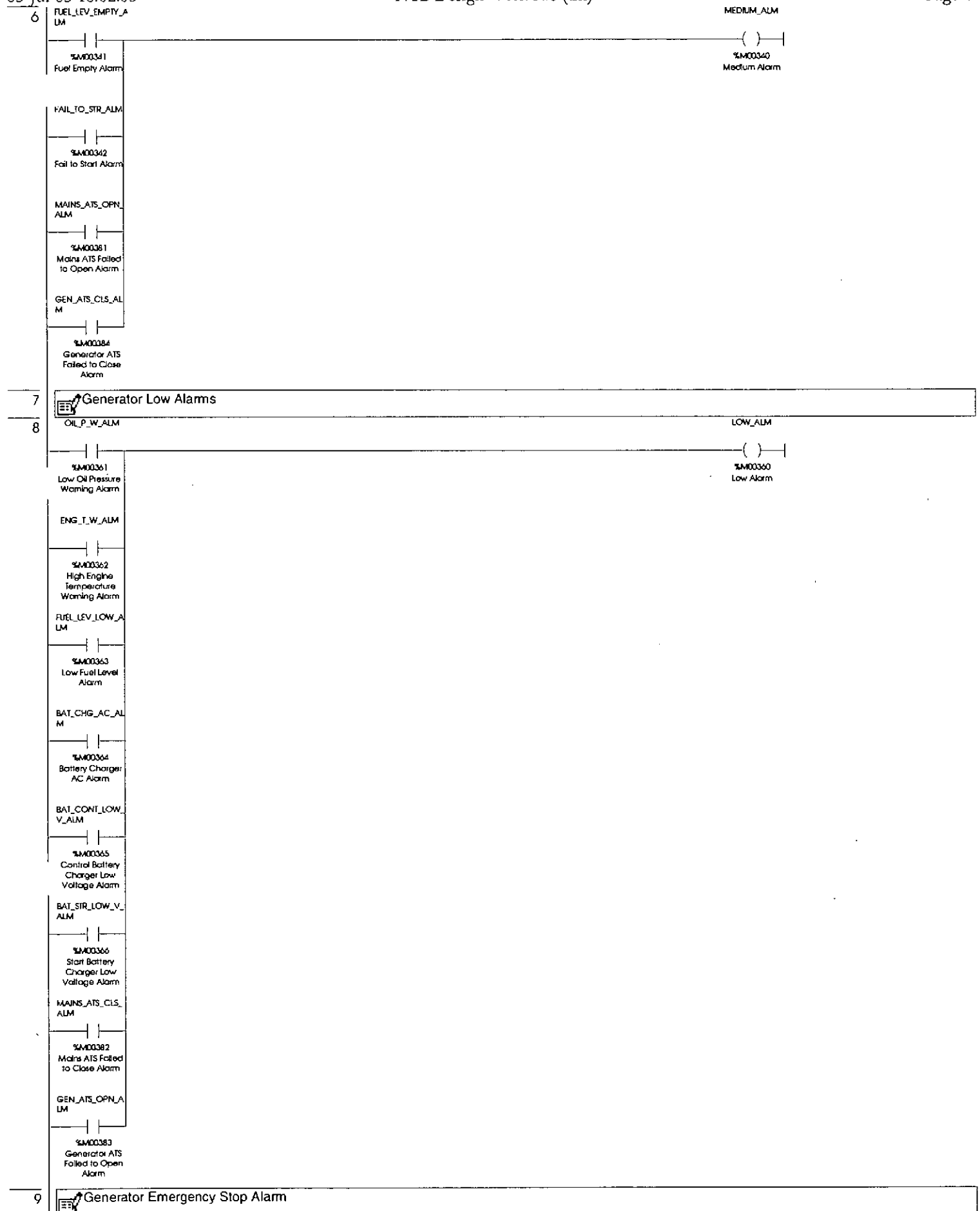
Block Name:.....ALARM.blk  
Description:.....Control Logic for the Generator Alarms.  
Block Type:.....Ladder



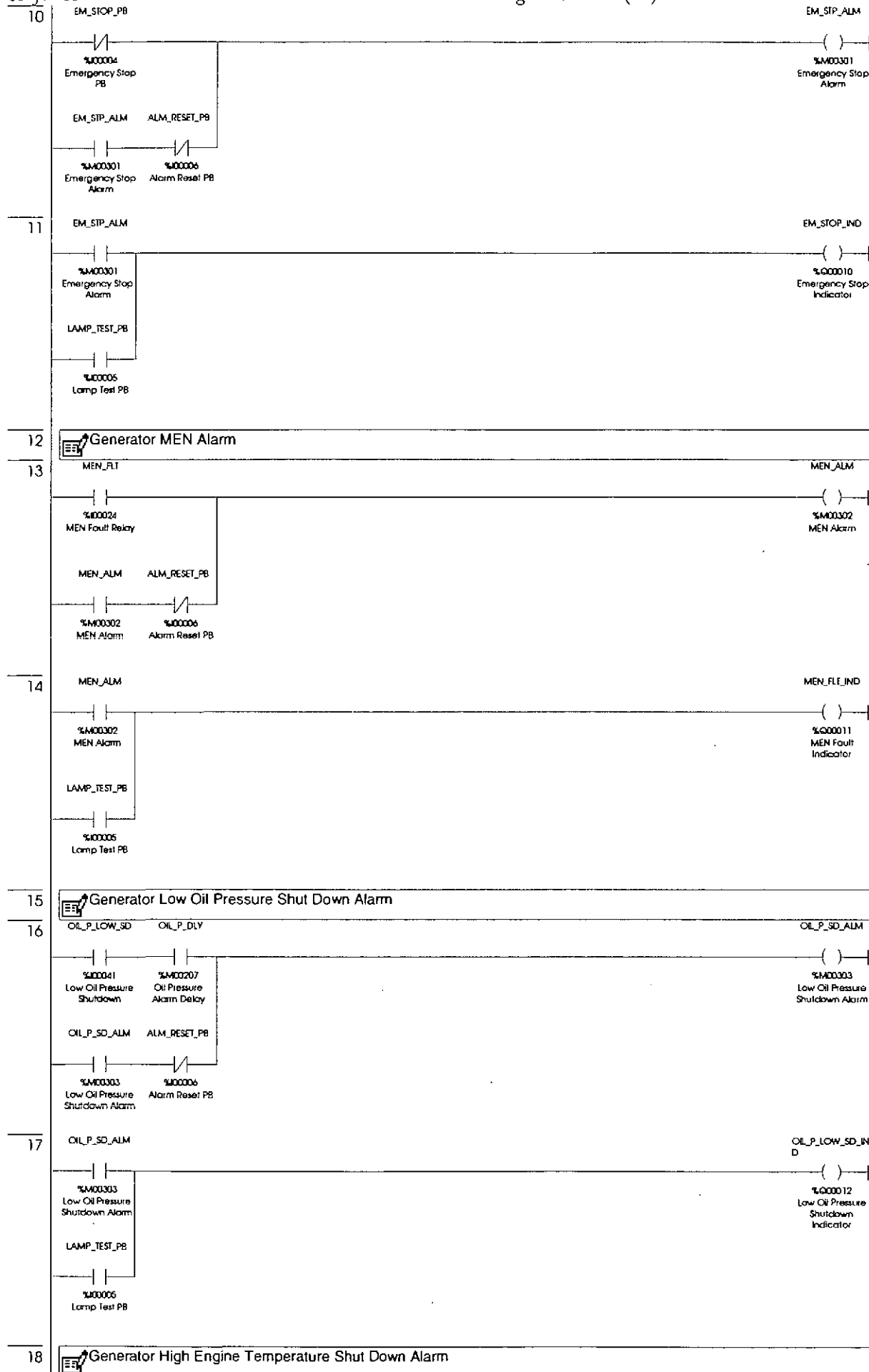
03-Jul-03 18:02:05

NTB Design VersaPro (tm)

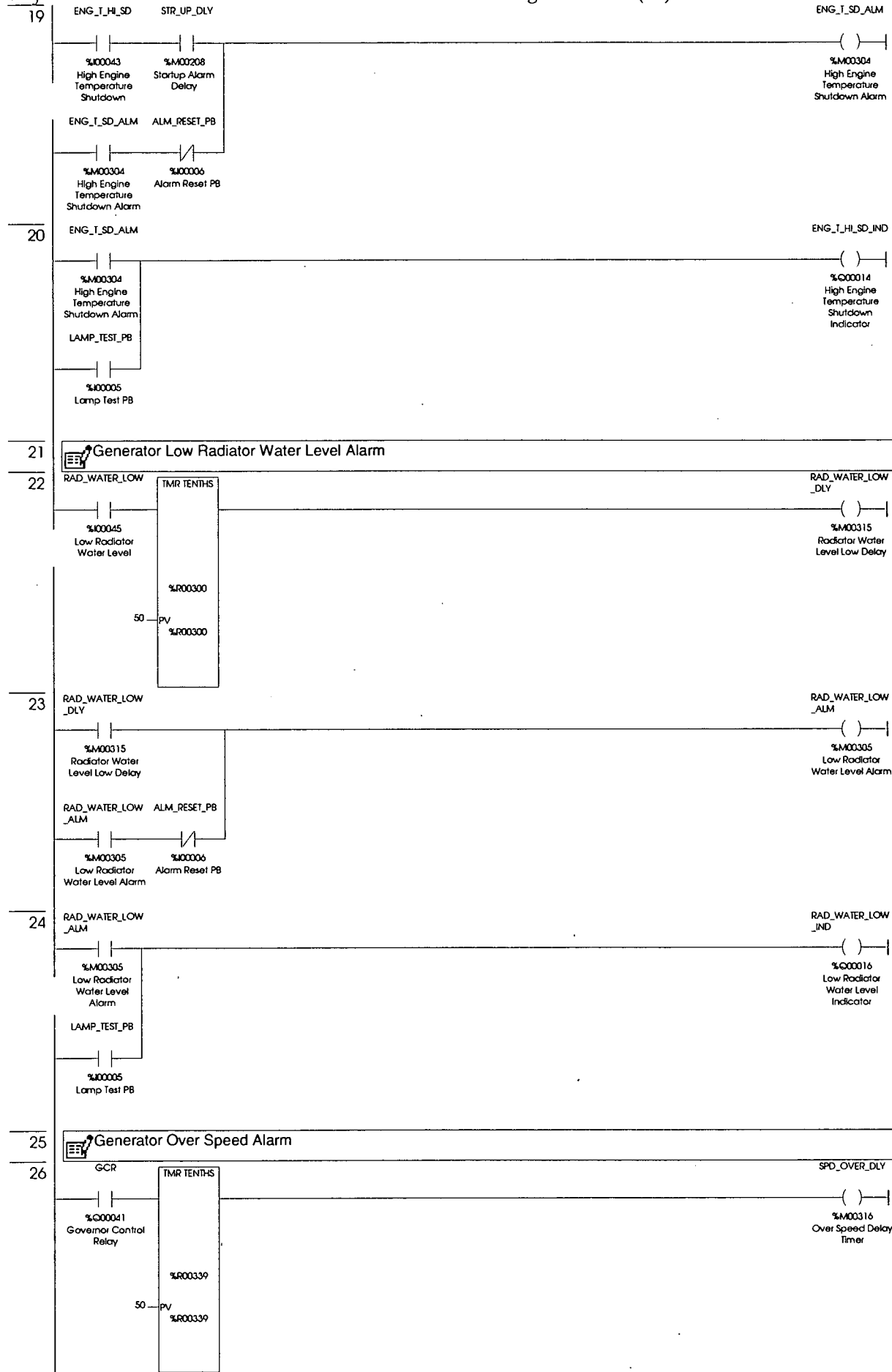
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03-Jul-03 18:02:05

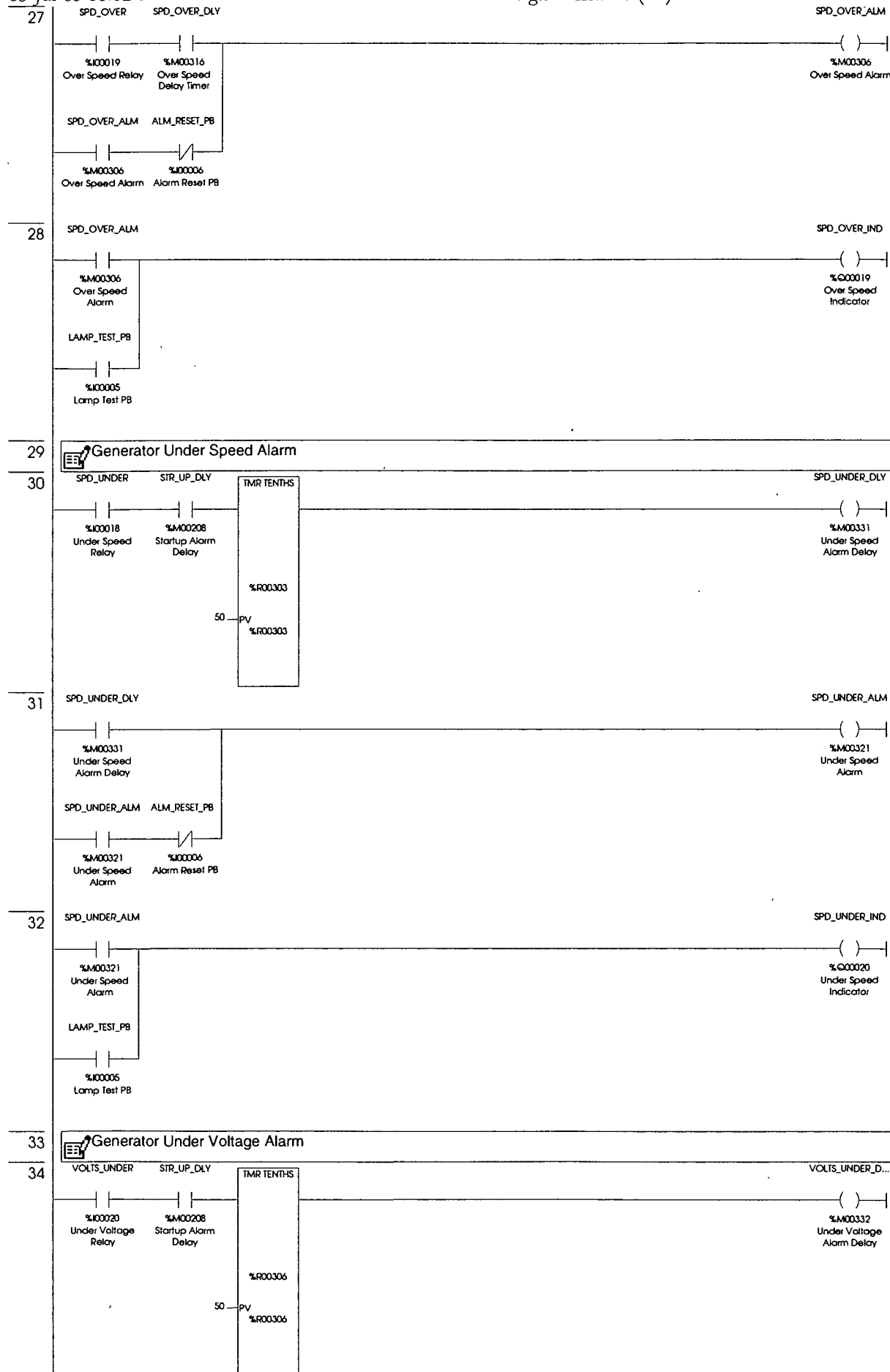


03-Jul-03 18:02:05

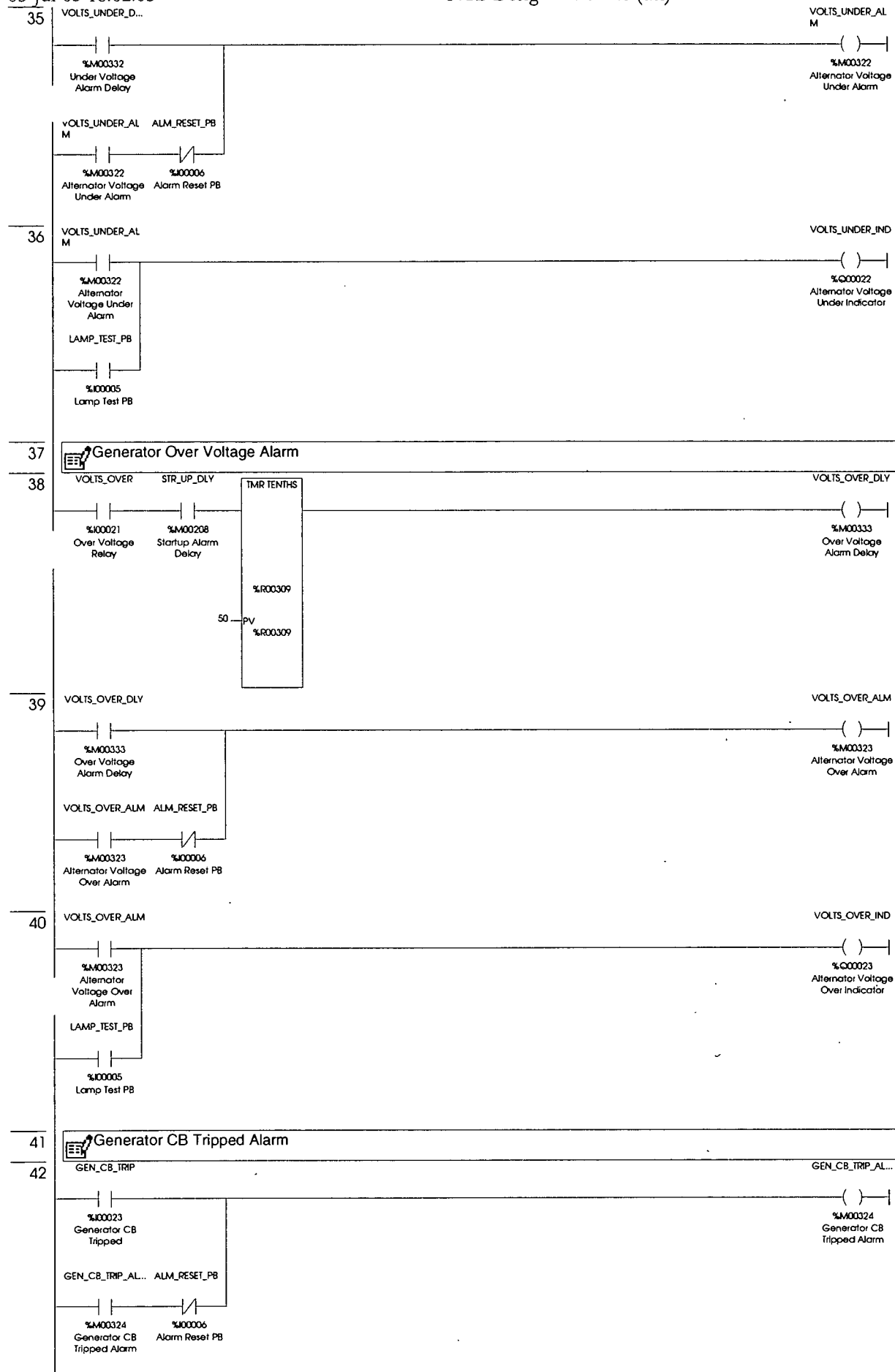


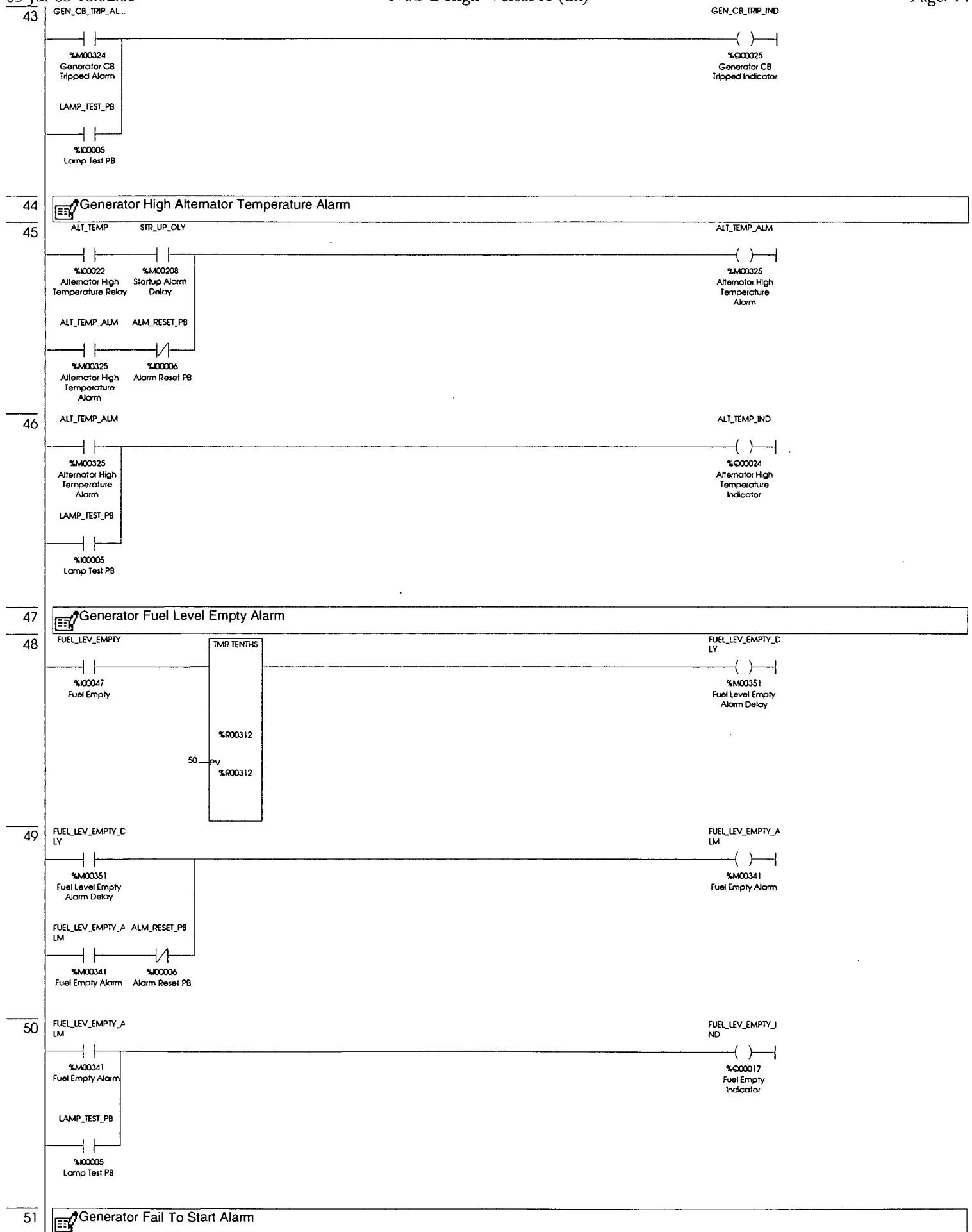
03-Jul-03 18:02:05

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03-Jul-03 18:02:05

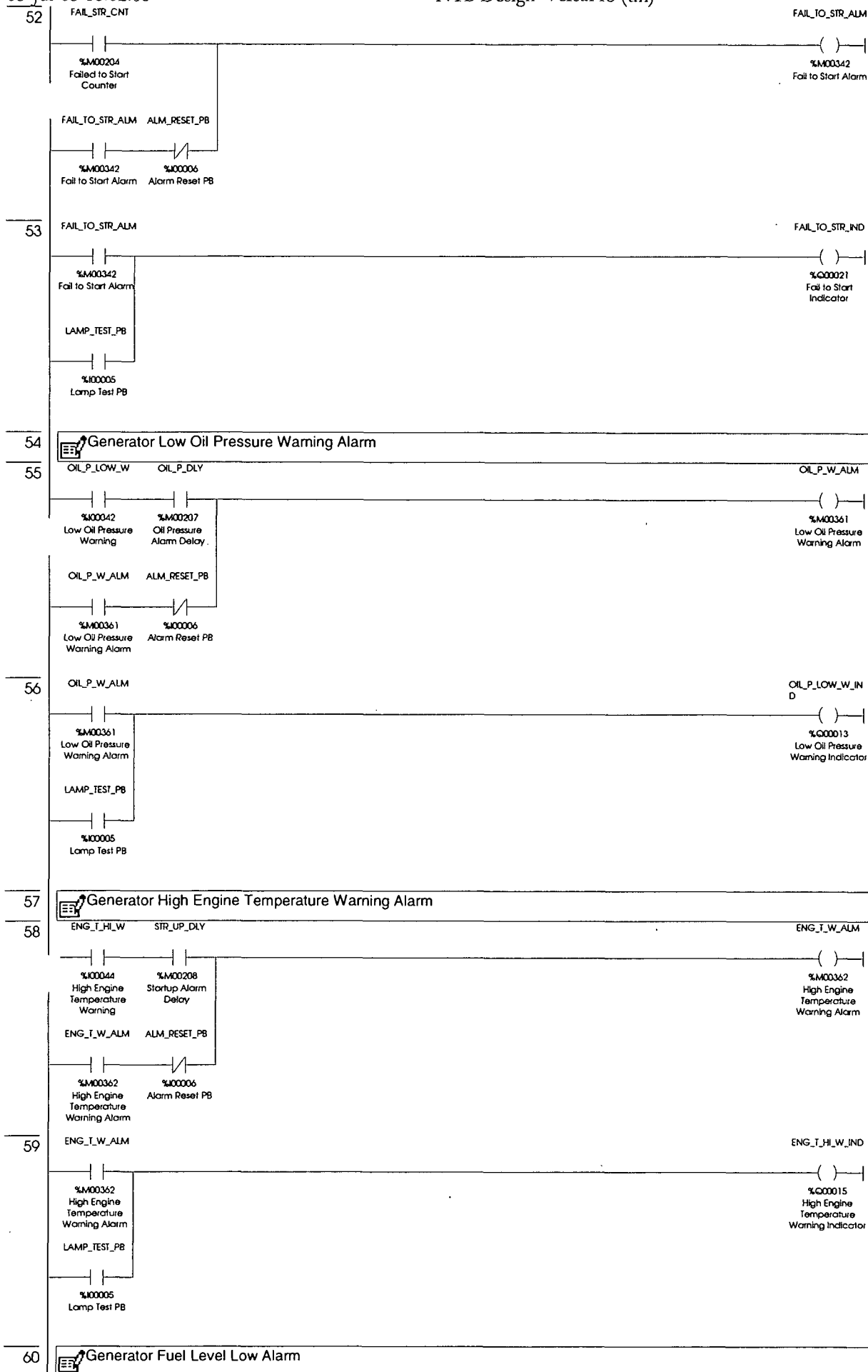




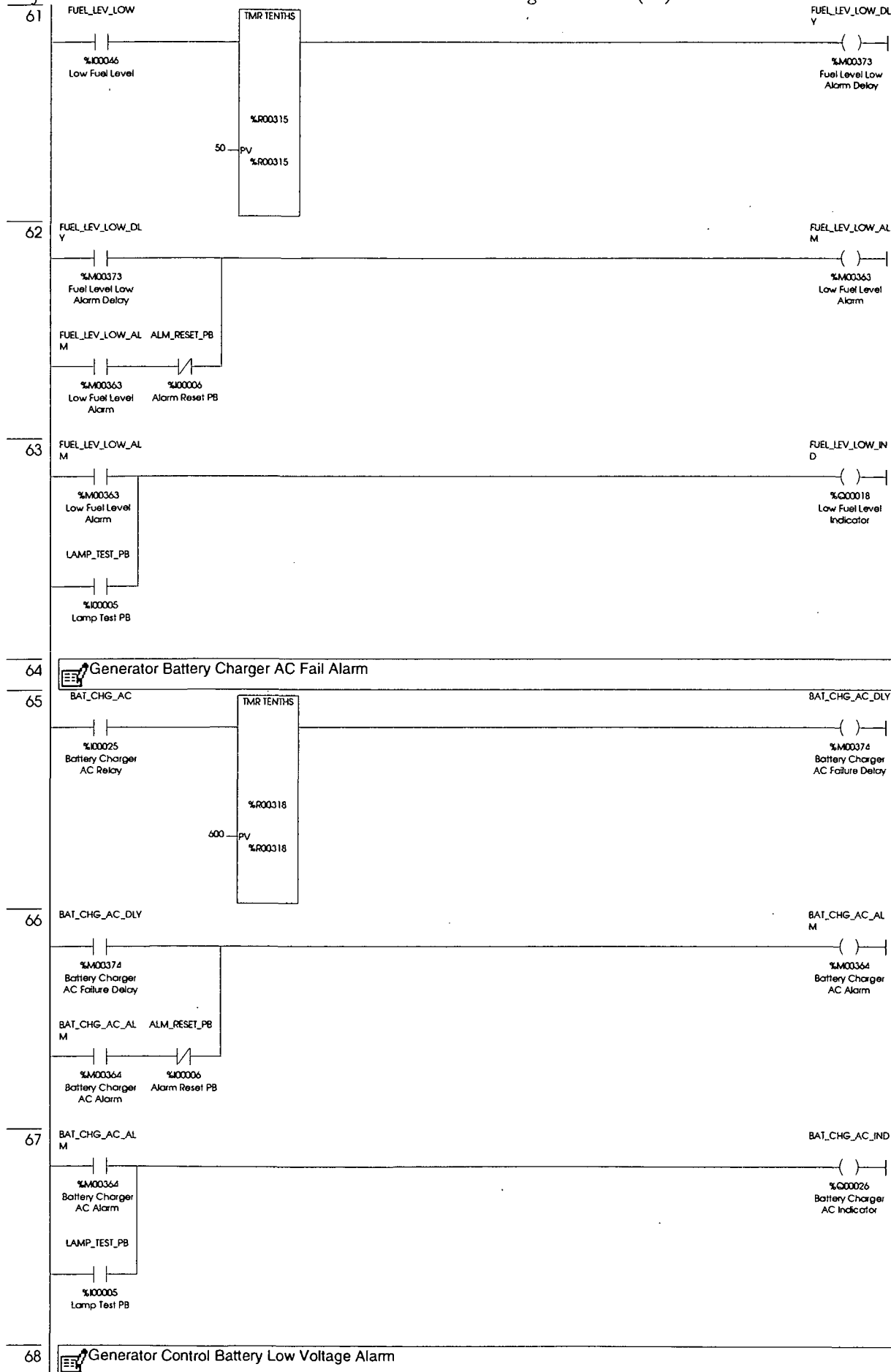
03-Jul-03 18:02:05

NTB Design VersaPro (tm)

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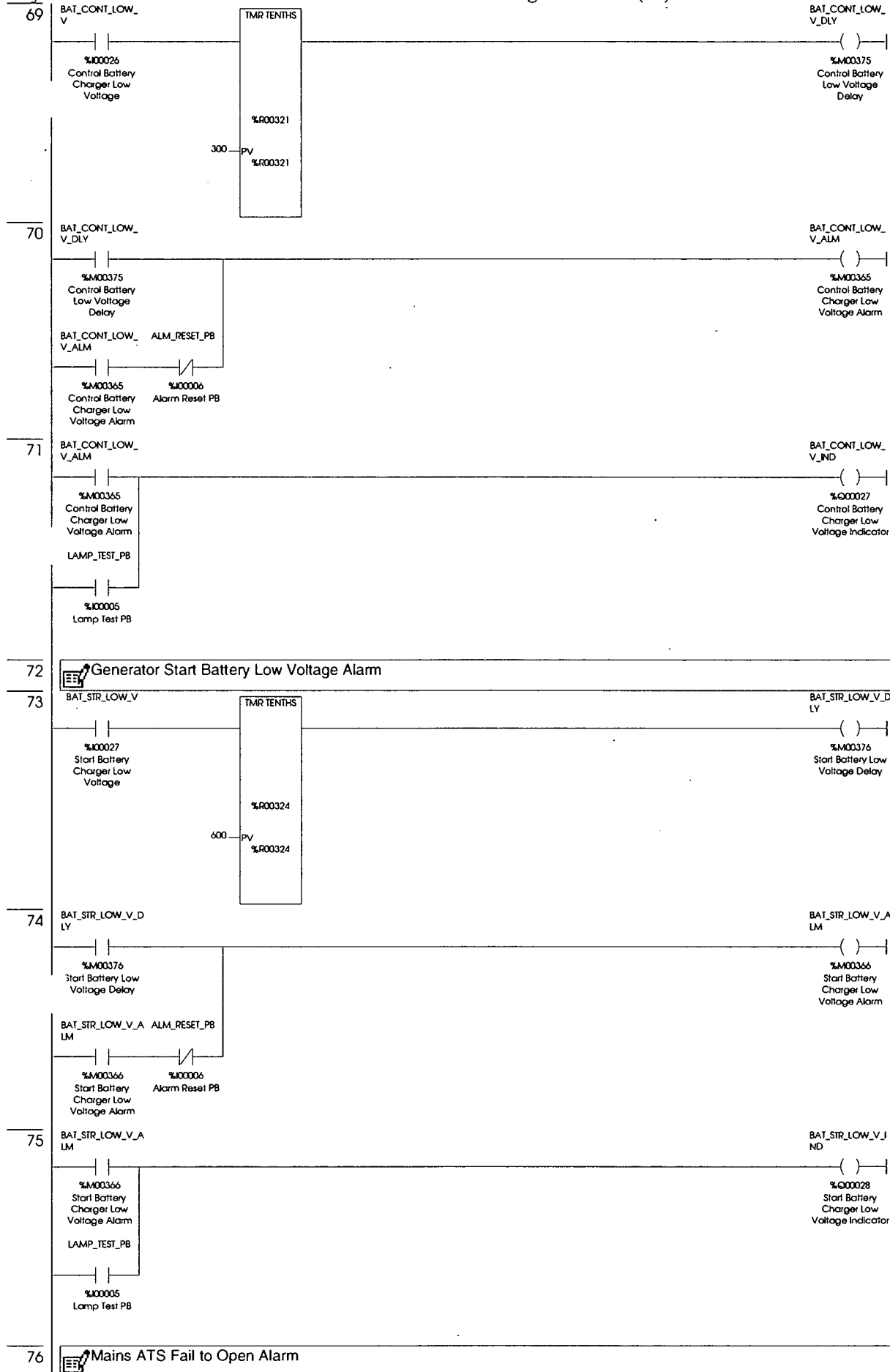
03-Jul-03 18:02:05



03-Jul-03 18:02:05

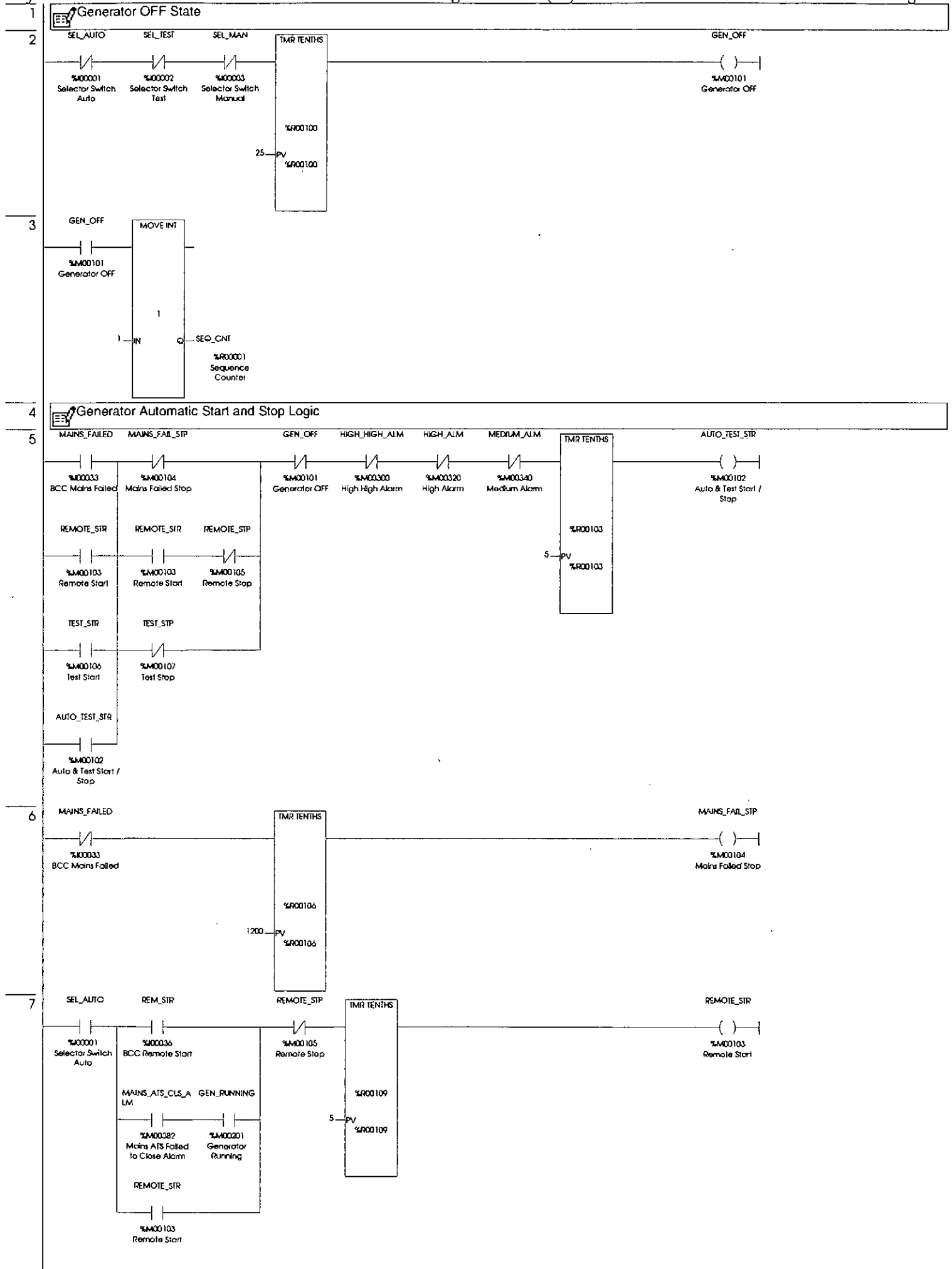
NTB Design VersaPro (tm)

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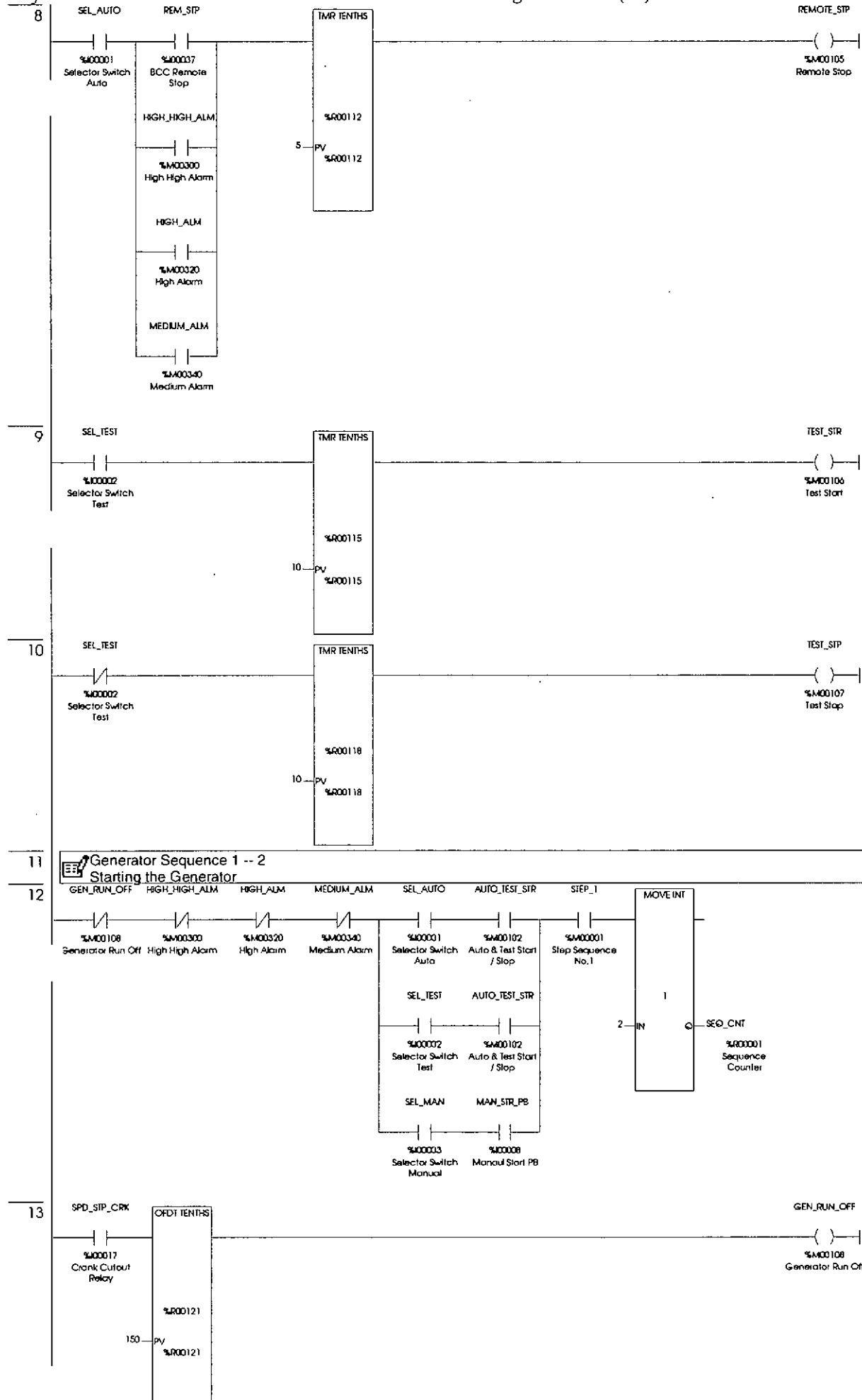




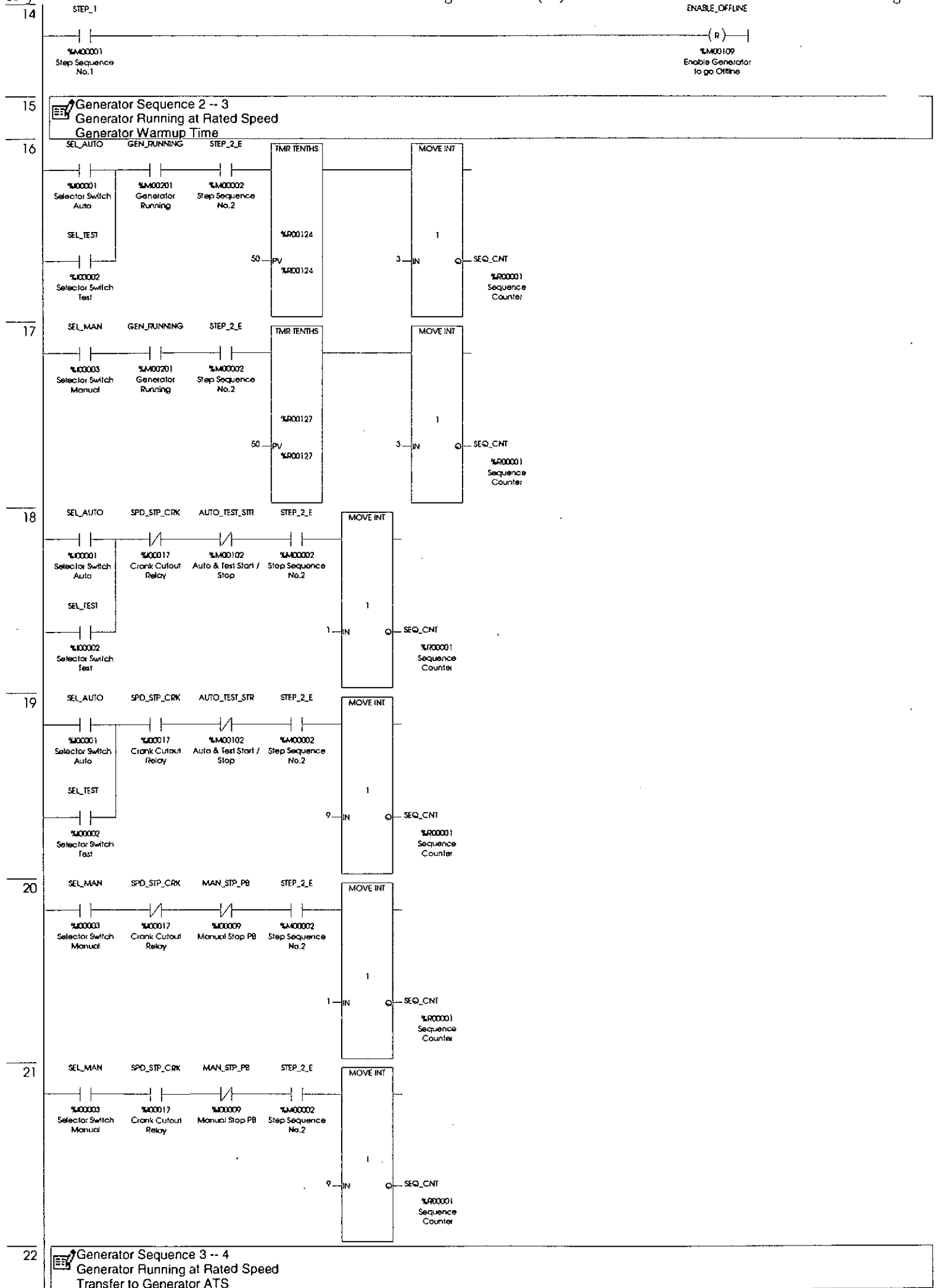
Block Name:.....SEQ.blk  
Description:.....Control Logic for the Generator Operation Sequences.  
Block Type:.....Ladder



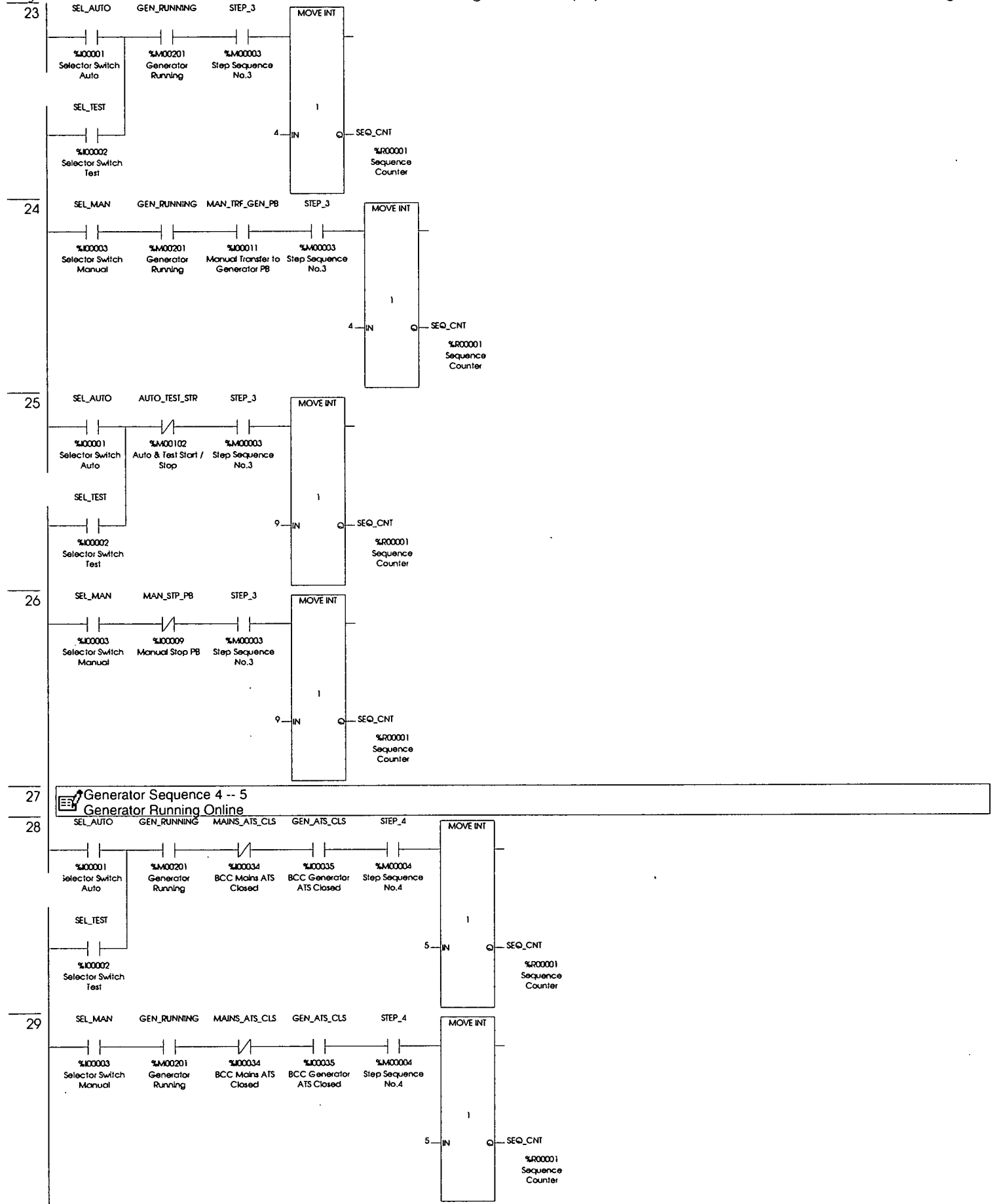
03-Jul-03 18:02:05



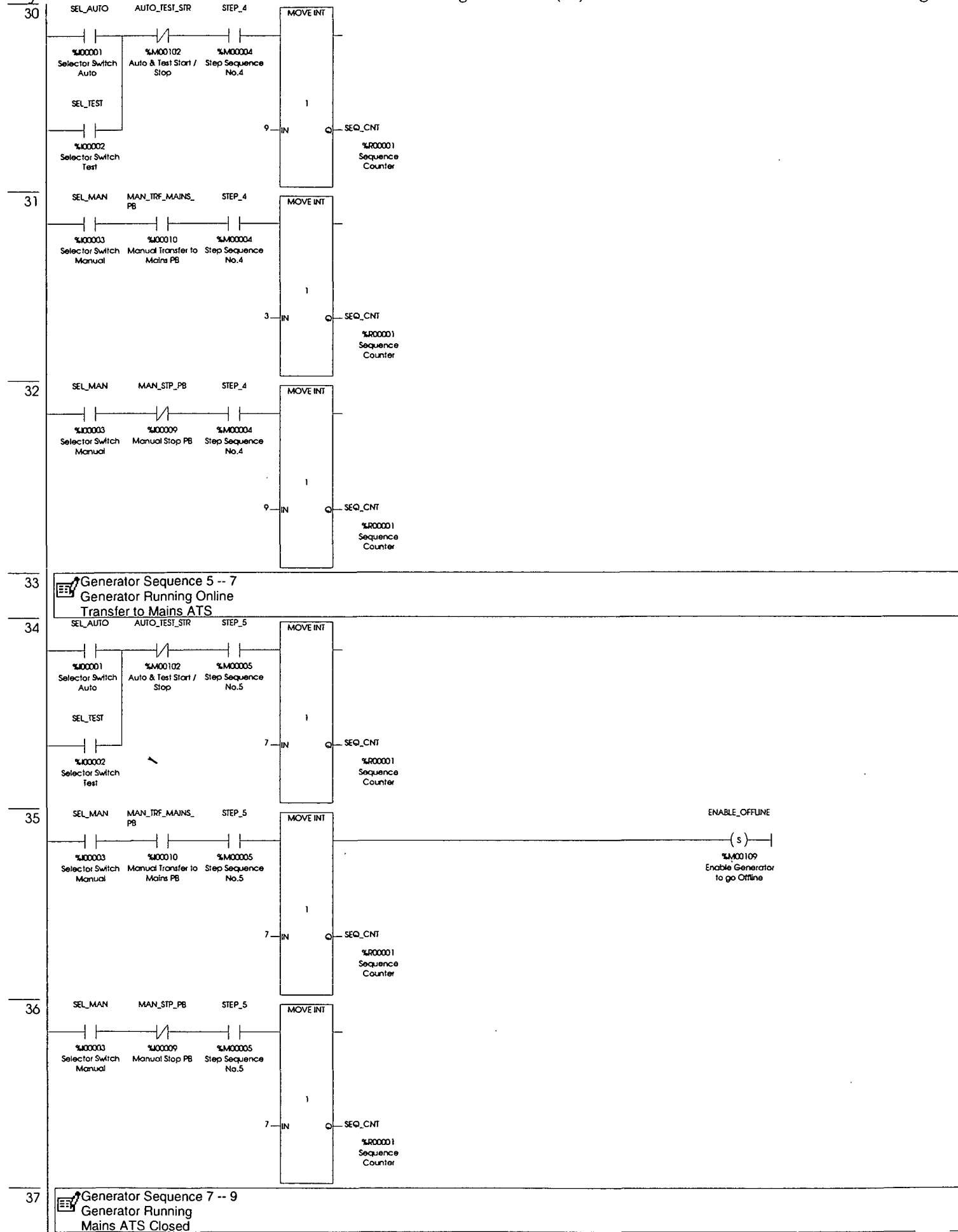
03-Jul-03 18:02:05

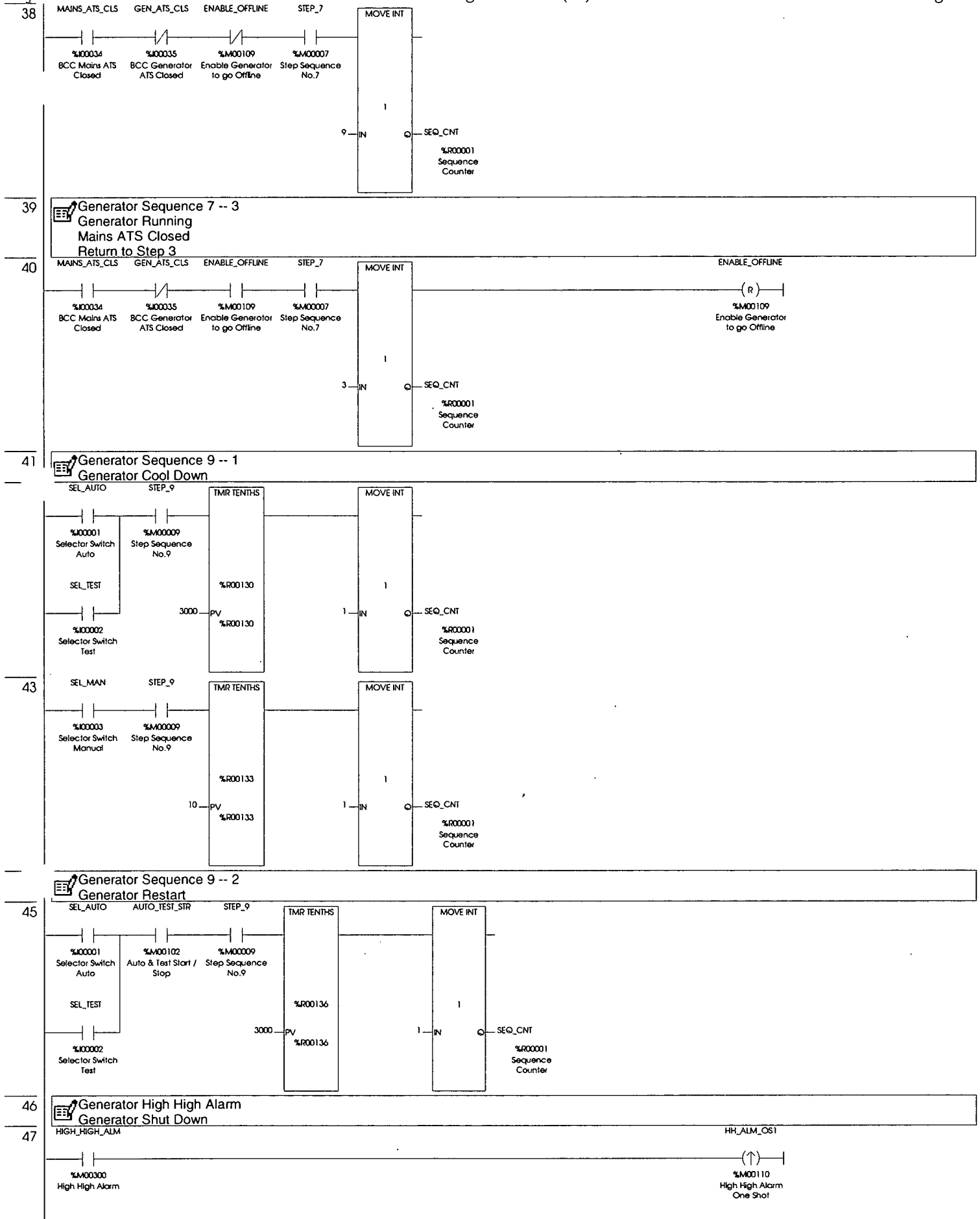


03-Jul-03 18:02:05

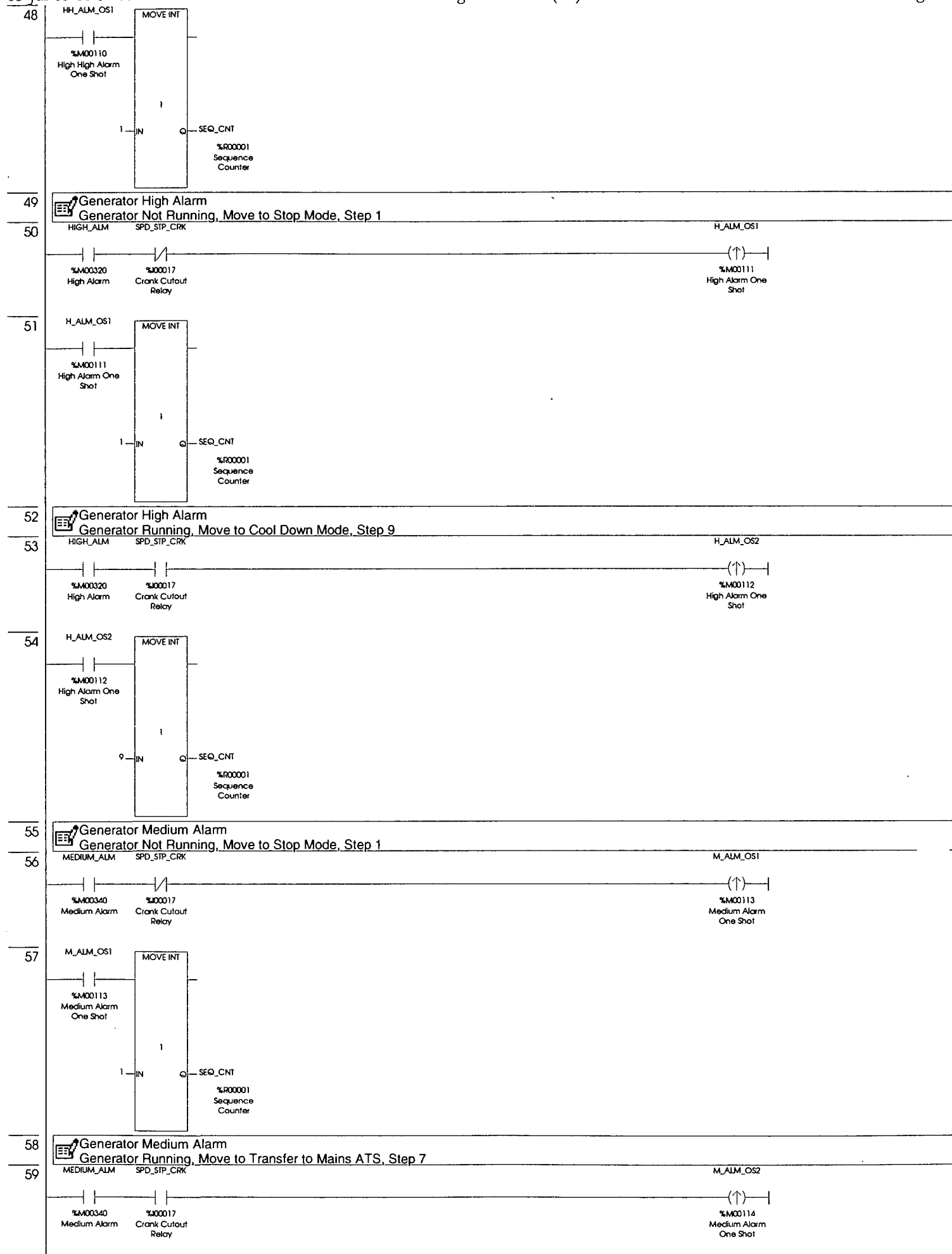


03-Jul-03 18:02:05

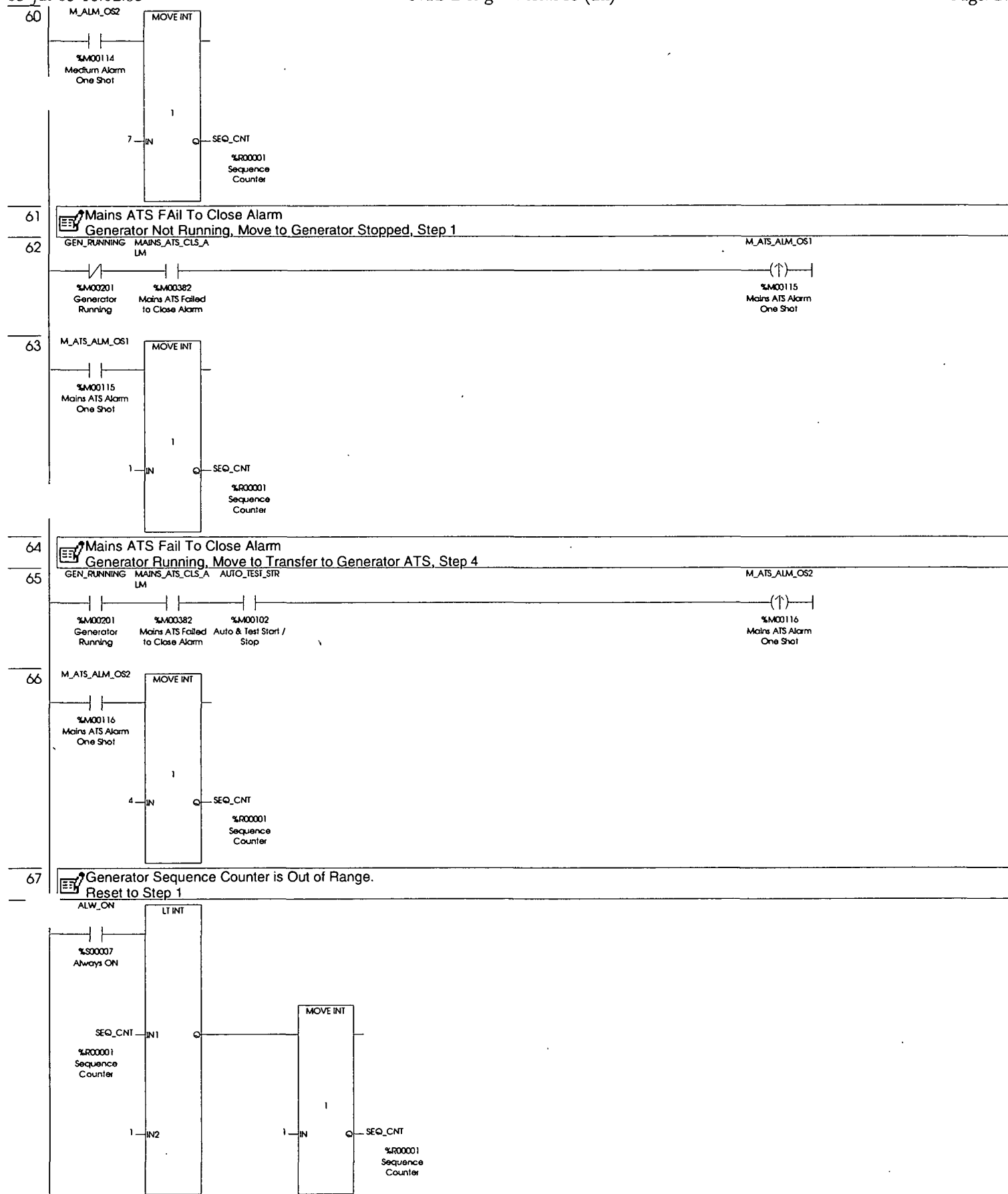


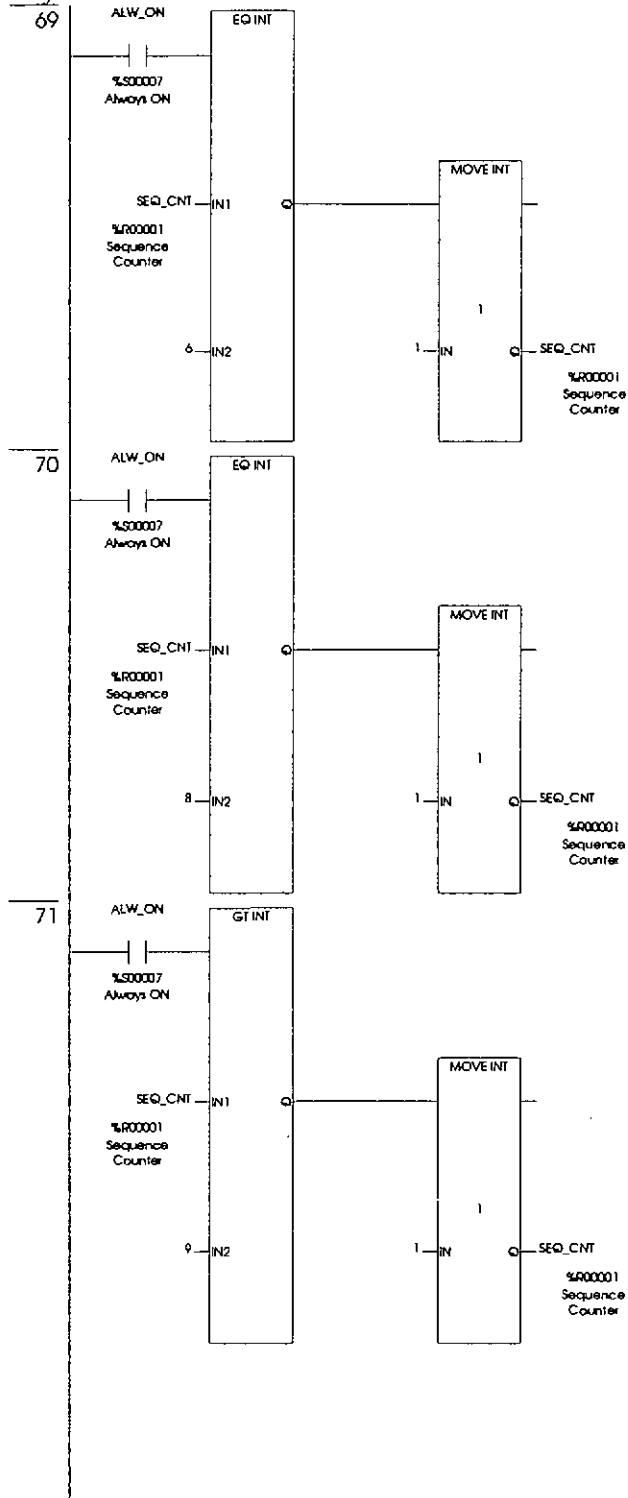


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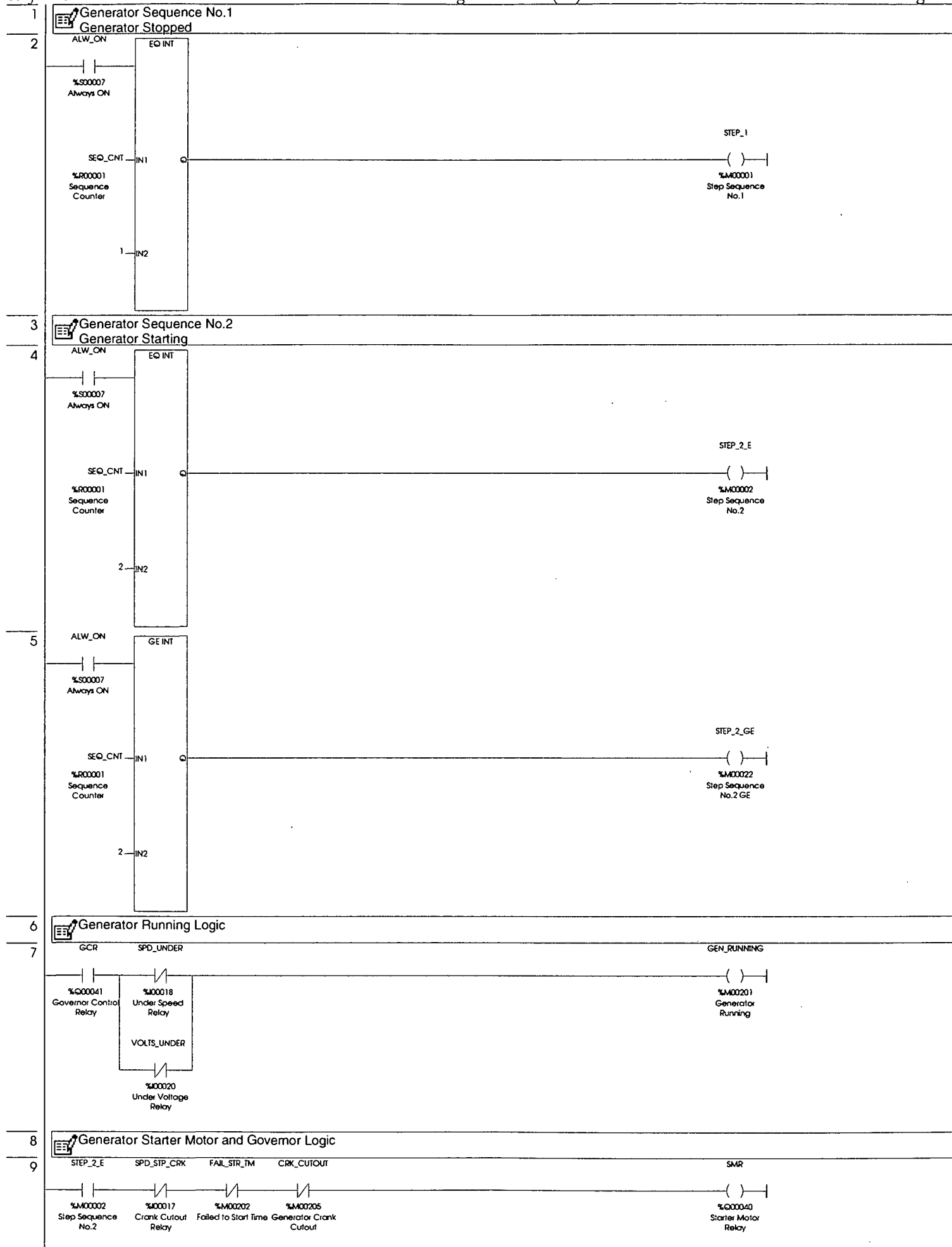


03-Jul-03 18:02:05

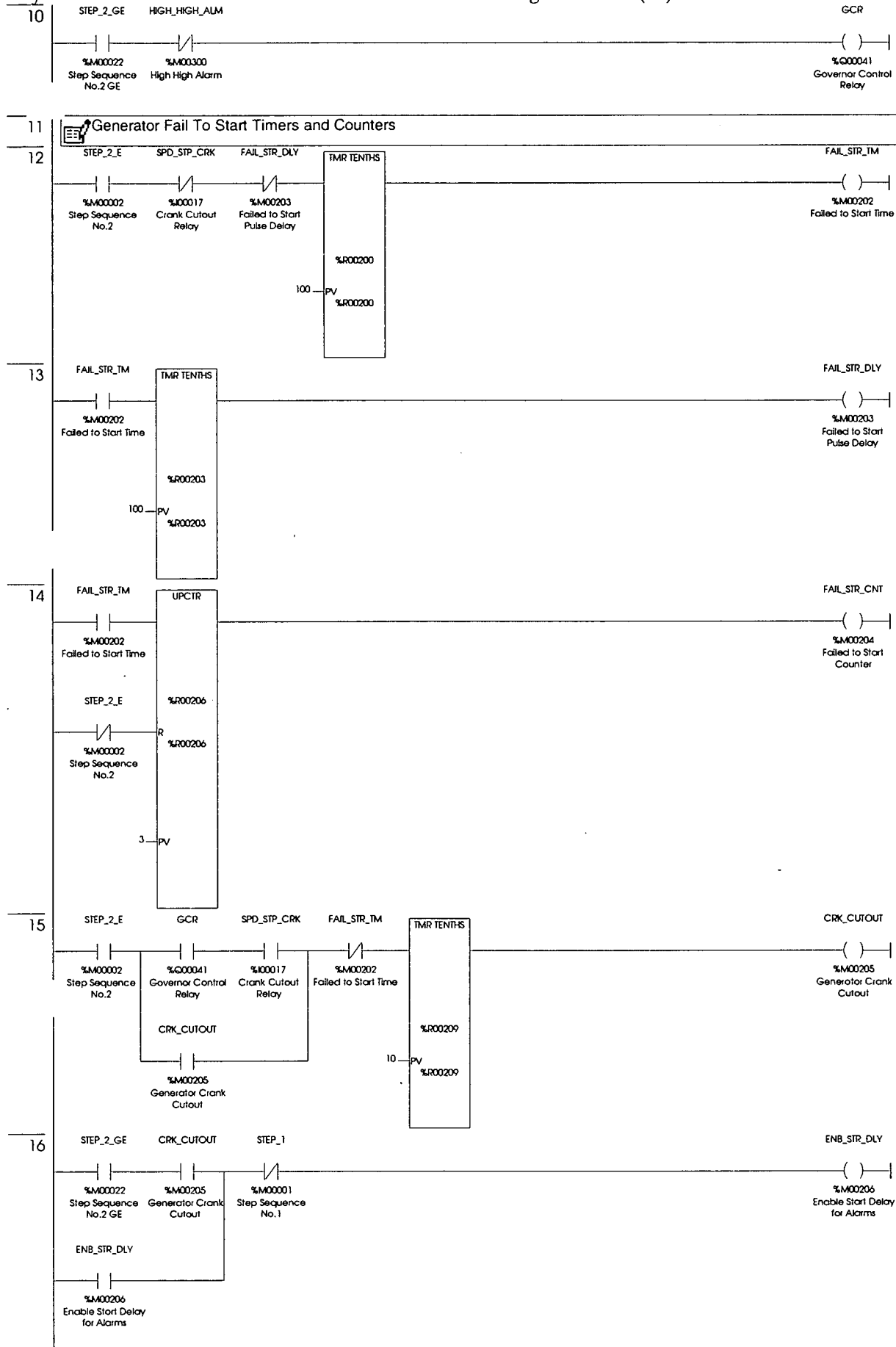




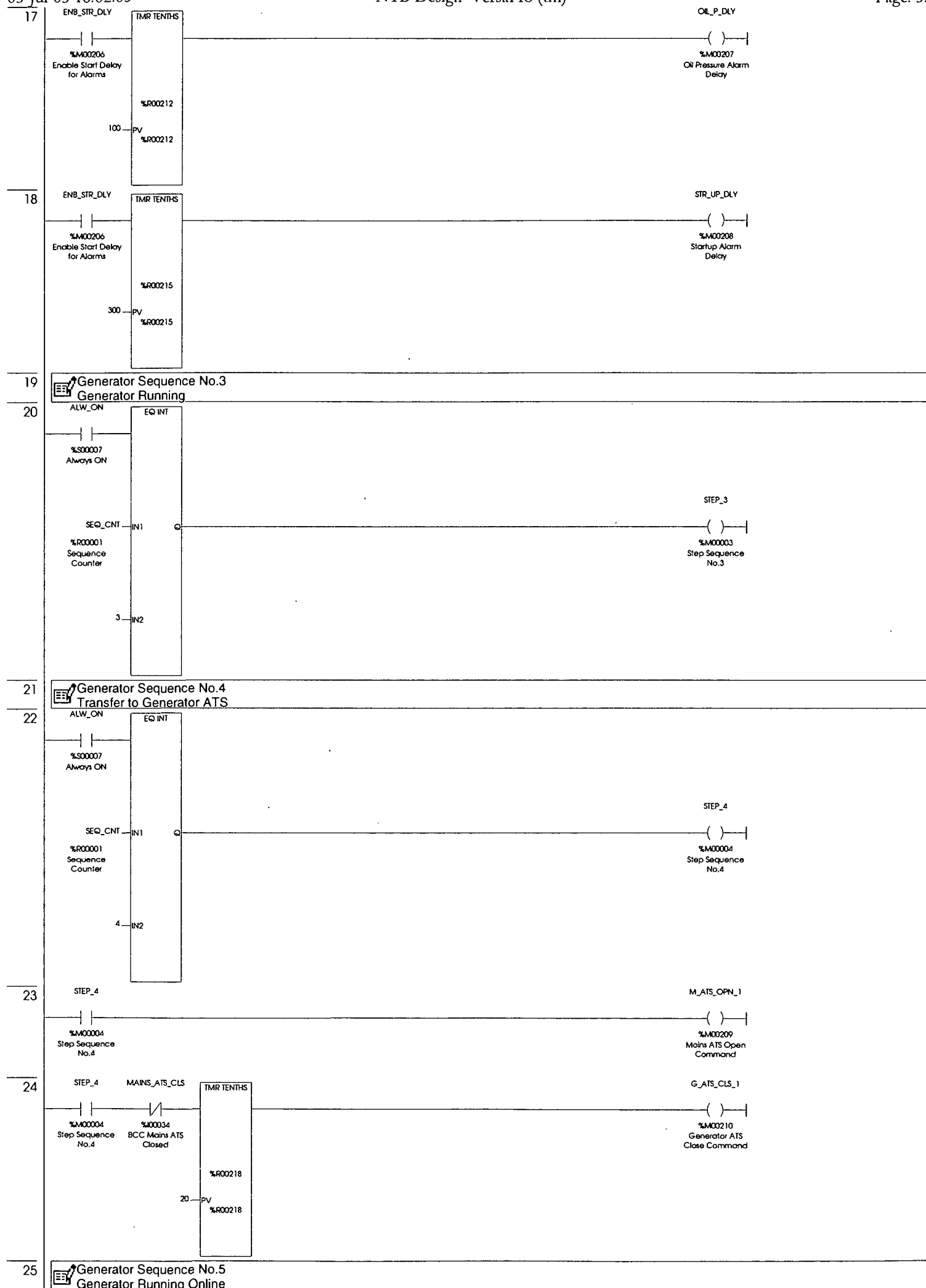
Block Name:..... MAIN.blk  
Description:..... Control Logic for the Generator Sequence Steps.  
Block Type:..... Ladder



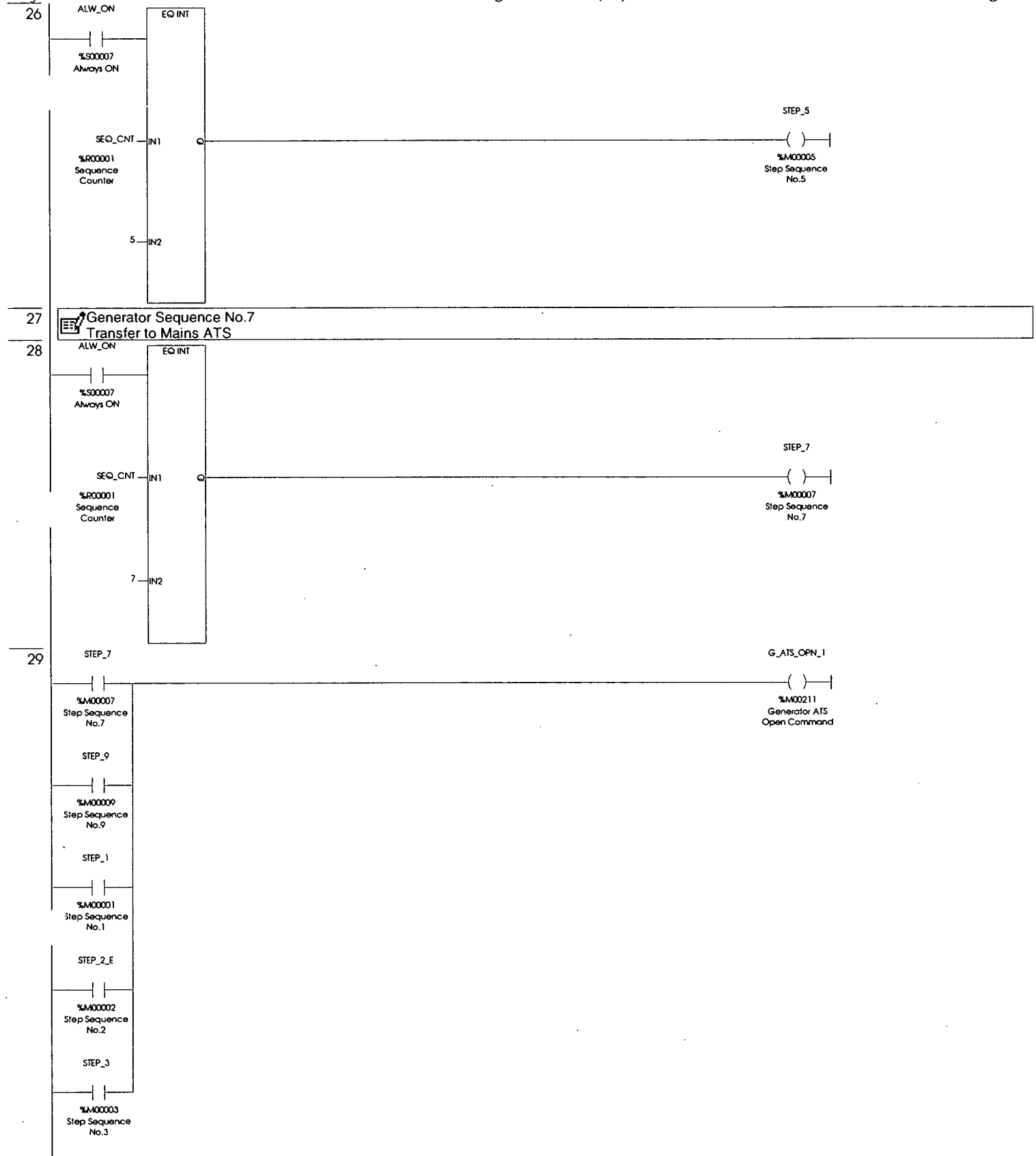
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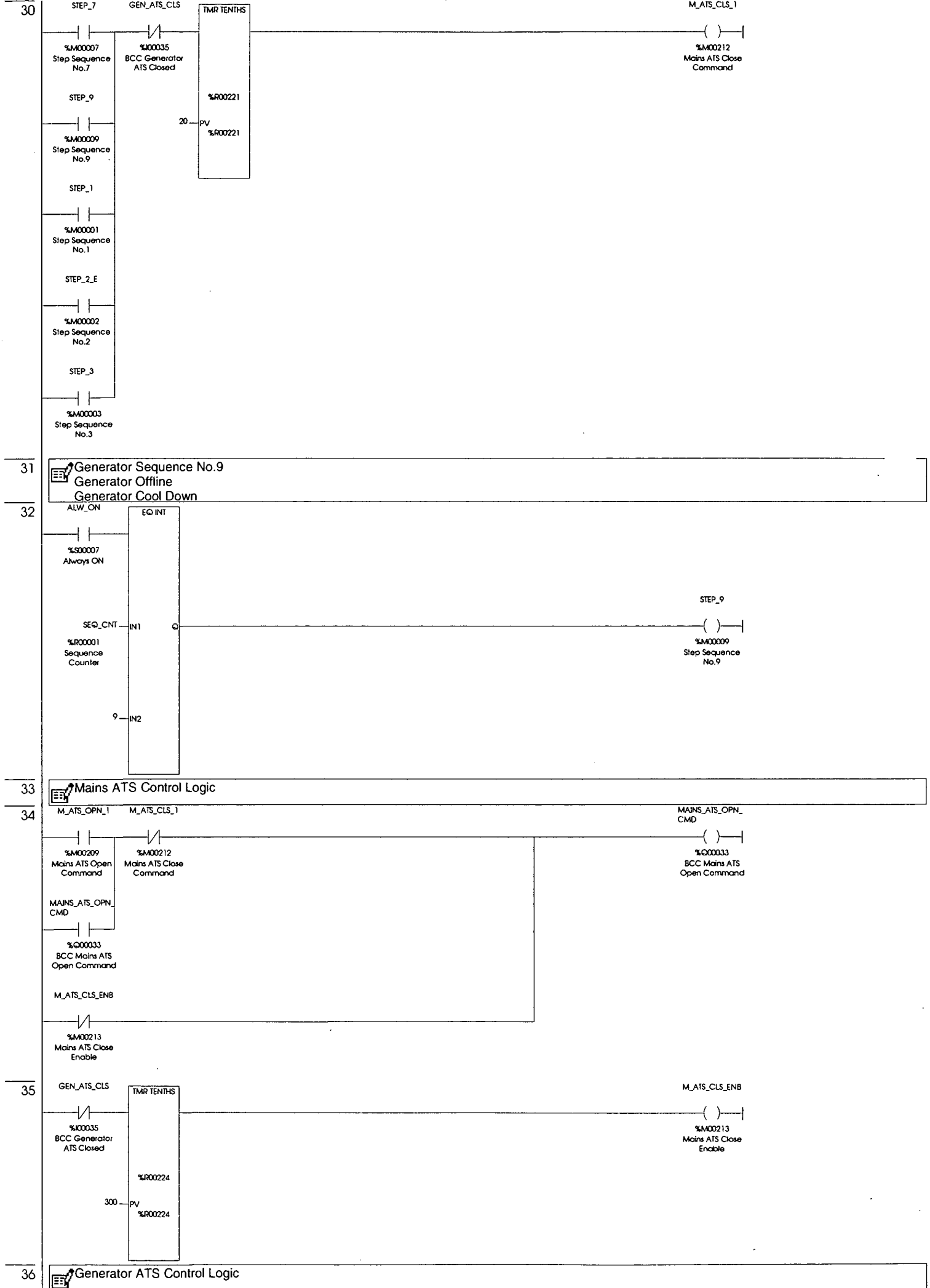
03-Jul-03 18:02:05



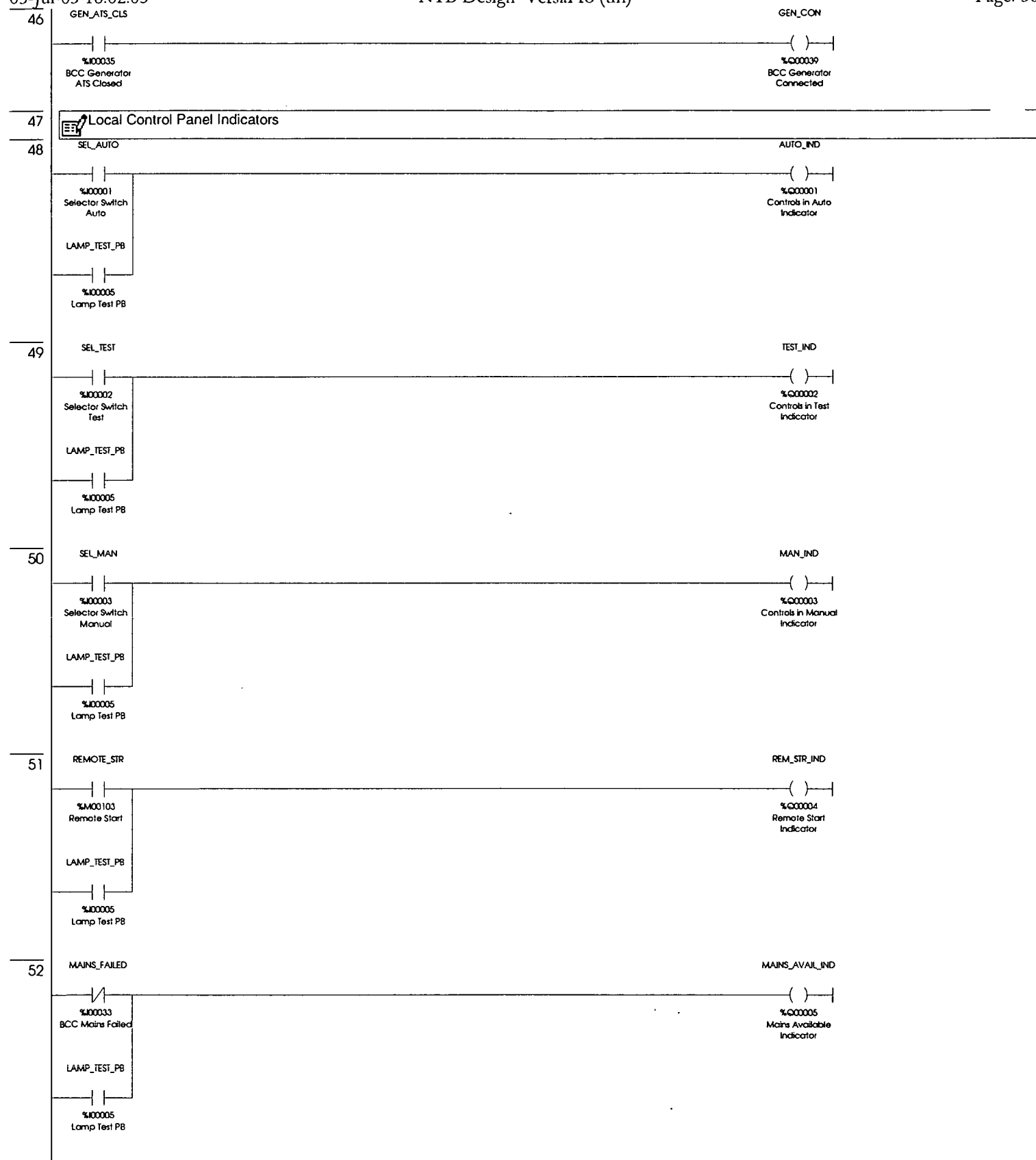
03-Jul-03 18:02:05



03-Jul-03 18:02:05



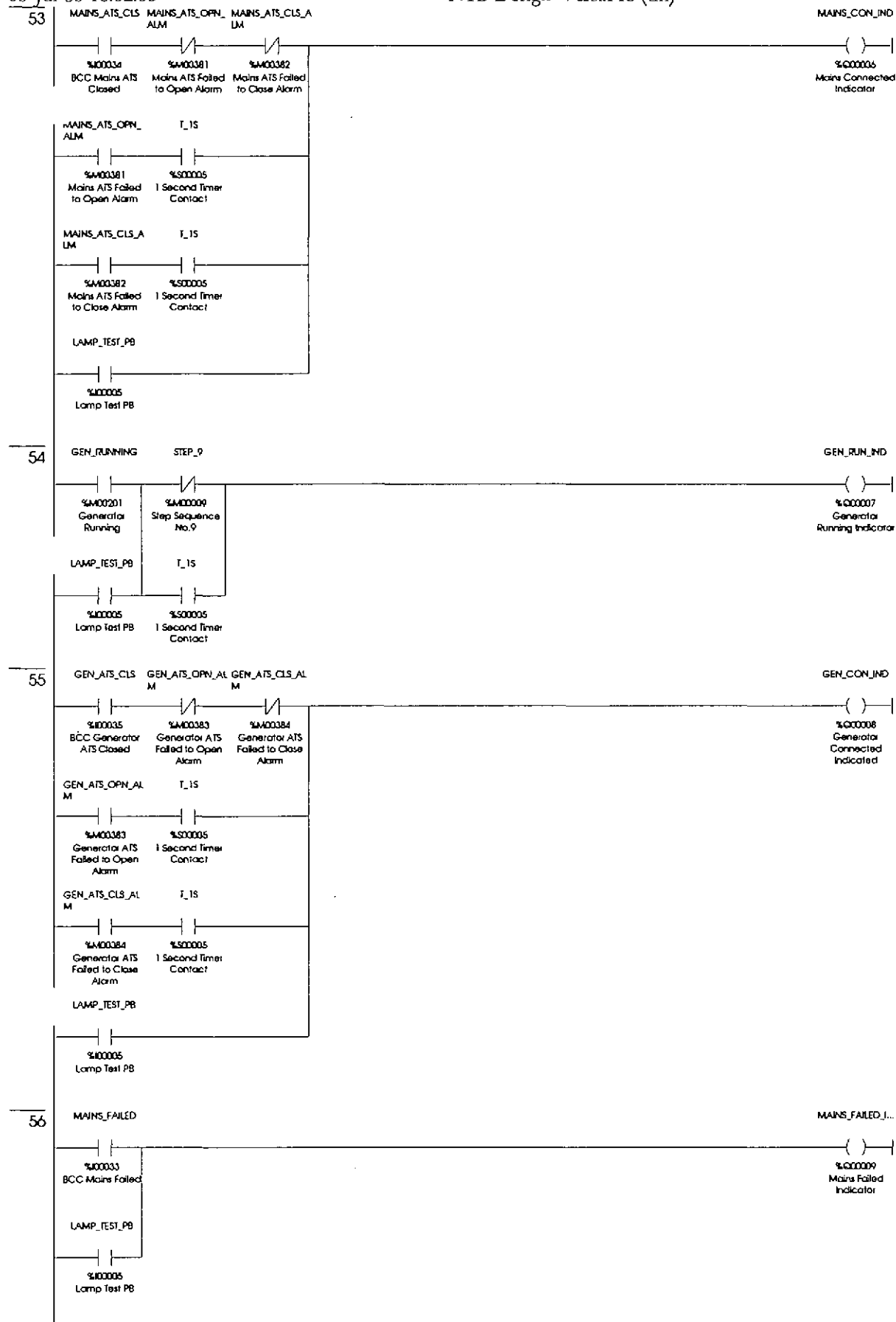




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NTB Design VersaPro (tm)

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CAN\_DOORS\_OPE  
N\_IND

%Q00029  
Canopy Doors  
Open Indicator

CAN\_DOORS\_OPE  
N  
%I00048  
Canopy Doors  
Open  
LAMP\_TEST\_PB  
%I00005  
Lamp Test PB

Block Name:.....\_MAIN.blk  
Description:.....Control Logic for the Call for Sub Routines.  
Block Type:.....Ladder

1

Written for EPAC.

2

Project: Brisbane City Council, Standby Generator Program.

FST\_SCN

PRESETS

CALL

%S00001

Set to 1 when the  
current sweep is  
the first sweep

3

SEQ

CALL

4

MAIN

CALL

5

ALARM

CALL

6

AUD\_ALM

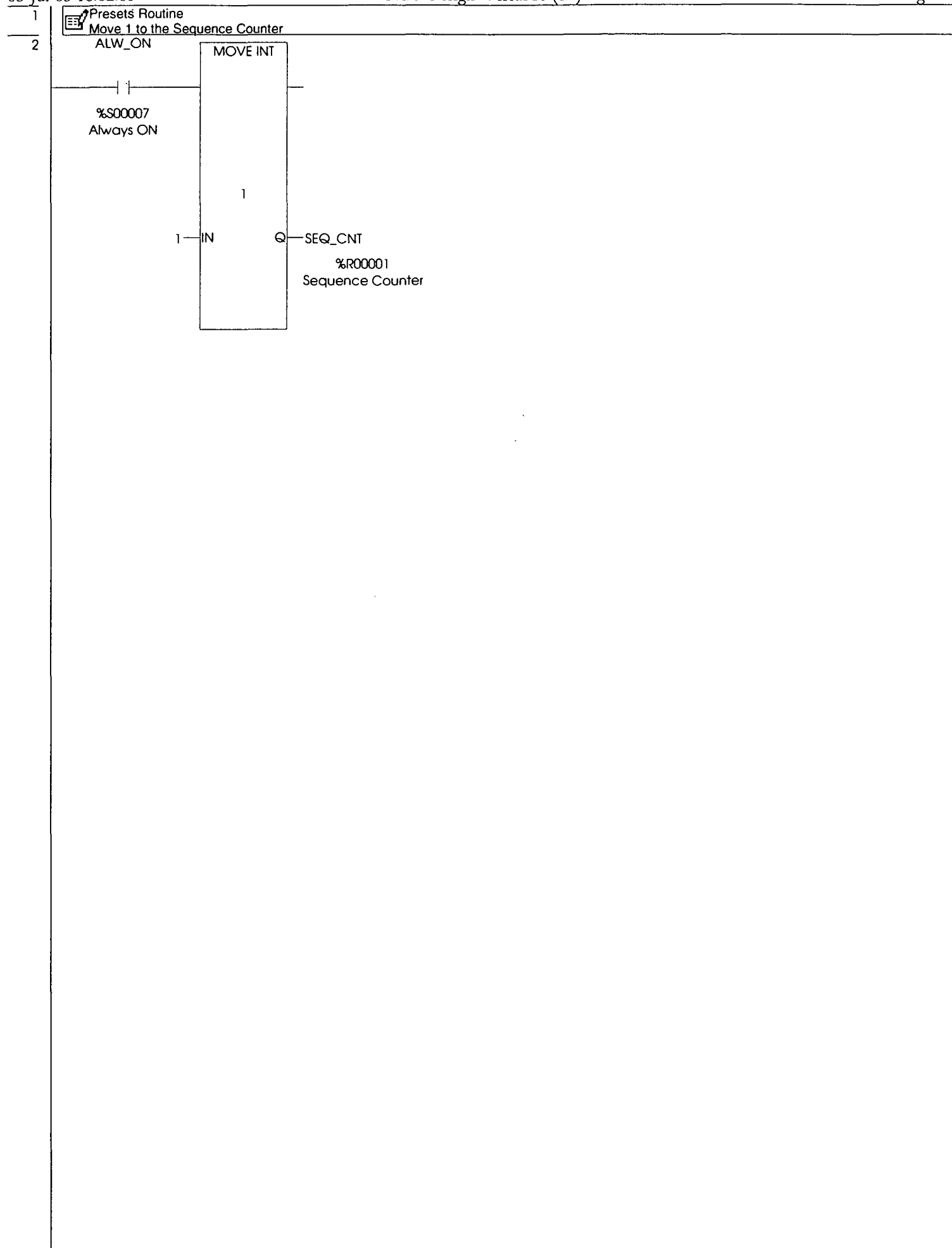
CALL

7

MODBUS

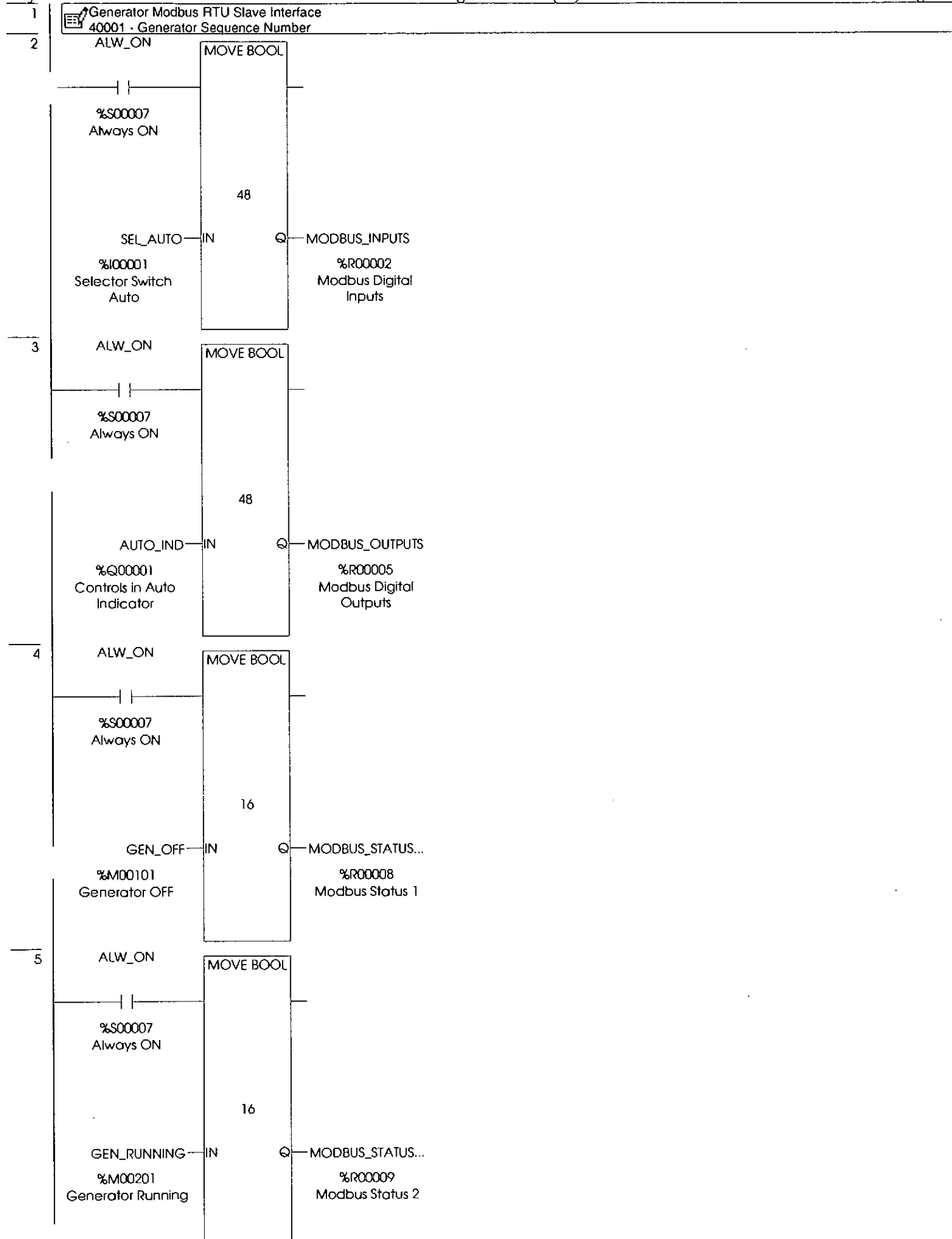
CALL

Block Name:.....PRESETS.blk  
Description:.....Control Logic Generator Presets.  
Block Type:.....Ladder





Block Name:.....MODBUS.blk  
Description:..... Control Logic for the Modbus RTU Communications Data.  
Block Type:.....Ladder



03-Jul-03 18:02:05

6

ALW\_ON

MOVE BOOL

%S00007  
Always ON

100

HIGH\_HIGH\_ALM — IN  
%M00300  
High High Alarm

Q — MODBUS\_ALARMS  
%R00010  
Modbus Alarms

## GLOBAL VARIABLES

| Name             | Type | Len | Address | Description                         | Stored Val | Scope  | Ret | Ovr | Ext |
|------------------|------|-----|---------|-------------------------------------|------------|--------|-----|-----|-----|
| SE_JTO           | BIT  | 1   | %I00001 | Selector Switch Auto                |            | Global | R   |     |     |
| SE_TEST          | BIT  | 1   | %I00002 | Selector Switch Test                |            | Global | R   |     |     |
| SEL_MAN          | BIT  | 1   | %I00003 | Selector Switch Manual              |            | Global | R   |     |     |
| EM_STOP_PB       | BIT  | 1   | %I00004 | Emergency Stop PB                   |            | Global | R   |     |     |
| LAMP_TEST_PB     | BIT  | 1   | %I00005 | Lamp Test PB                        |            | Global | R   |     |     |
| ALM_RESET_PB     | BIT  | 1   | %I00006 | Alarm Reset PB                      |            | Global | R   |     |     |
| ALM_MUTE_PB      | BIT  | 1   | %I00007 | Alarm Mute PB                       |            | Global | R   |     |     |
| MAN_STR_PB       | BIT  | 1   | %I00008 | Manual Start PB                     |            | Global | R   |     |     |
| MAN_STP_PB       | BIT  | 1   | %I00009 | Manual Stop PB                      |            | Global | R   |     |     |
| MAN_TRF_MAINS_PB | BIT  | 1   | %I00010 | Manual Transfer to Mains PB         |            | Global | R   |     |     |
| MAN_TRF_GEN_PB   | BIT  | 1   | %I00011 | Manual Transfer to Generator PB     |            | Global | R   |     |     |
| SPD_STP_CRK      | BIT  | 1   | %I00017 | Crank Cutout Relay                  |            | Global | R   |     |     |
| SPD_UNDER        | BIT  | 1   | %I00018 | Under Speed Relay                   |            | Global | R   |     |     |
| SPD_OVER         | BIT  | 1   | %I00019 | Over Speed Relay                    |            | Global | R   |     |     |
| VOLTS_UNDER      | BIT  | 1   | %I00020 | Under Voltage Relay                 |            | Global | R   |     |     |
| VOLTS_OVER       | BIT  | 1   | %I00021 | Over Voltage Relay                  |            | Global | R   |     |     |
| ALT_TEMP         | BIT  | 1   | %I00022 | Alternator High Temperature Relay   |            | Global | R   |     |     |
| GEN_CB_TRIP      | BIT  | 1   | %I00023 | Generator CB Tripped                |            | Global | R   |     |     |
| MEN_FLT          | BIT  | 1   | %I00024 | MEN Fault Relay                     |            | Global | R   |     |     |
| BAT_CHG_AC       | BIT  | 1   | %I00025 | Battery Charger AC Relay            |            | Global | R   |     |     |
| BAT_CONT_LOW_V   | BIT  | 1   | %I00026 | Control Battery Charger Low Voltage |            | Global | R   |     |     |
| BAT_TR_LOW_V     | BIT  | 1   | %I00027 | Start Battery Charger Low Voltage   |            | Global | R   |     |     |
| MAINS_FAILED     | BIT  | 1   | %I00033 | BCC Mains Failed                    |            | Global | R   |     |     |
| MAINS_ATS_CLS    | BIT  | 1   | %I00034 | BCC Mains ATS Closed                |            | Global | R   |     |     |
| GEN_ATS_CLS      | BIT  | 1   | %I00035 | BCC Generator ATS Closed            |            | Global | R   |     |     |
| REM_STR          | BIT  | 1   | %I00036 | BCC Remote Start                    |            | Global | R   |     |     |
| REM_STP          | BIT  | 1   | %I00037 | BCC Remote Stop                     |            | Global | R   |     |     |
| OIL_P_LOW_SD     | BIT  | 1   | %I00041 | Low Oil Pressure Shutdown           |            | Global | R   |     |     |
| OIL_P_LOW_W      | BIT  | 1   | %I00042 | Low Oil Pressure Warning            |            | Global | R   |     |     |
| ENG_T_HI_SD      | BIT  | 1   | %I00043 | High Engine Temperature Shutdown    |            | Global | R   |     |     |
| ENG_T_HI_W       | BIT  | 1   | %I00044 | High Engine Temperature Warning     |            | Global | R   |     |     |
| RAD_WATER_LOW    | BIT  | 1   | %I00045 | Low Radiator Water Level            |            | Global | R   |     |     |
| FUEL_LEV_LOW     | BIT  | 1   | %I00046 | Low Fuel Level                      |            | Global | R   |     |     |
| FUEL_LEV_EMPTY   | BIT  | 1   | %I00047 | Fuel Empty                          |            | Global | R   |     |     |
| CAN_DOORS_OPEN   | BIT  | 1   | %I00048 | Canopy Doors Open                   |            | Global | R   |     |     |
| STEP_1           | BIT  | 1   | %M00001 | Step Sequence No.1                  |            | Global |     |     |     |
| STEP_2_E         | BIT  | 1   | %M00002 | Step Sequence No.2                  |            | Global |     |     |     |
| STEP_3           | BIT  | 1   | %M00003 | Step Sequence No.3                  |            | Global |     |     |     |
| STEP_4           | BIT  | 1   | %M00004 | Step Sequence No.4                  |            | Global |     |     |     |
| STEP_5           | BIT  | 1   | %M00005 | Step Sequence No.5                  |            | Global |     |     |     |
| STEP_6           | BIT  | 1   | %M00006 | Step Sequence No.6                  |            | Global |     |     |     |
| STEP_7           | BIT  | 1   | %M00007 | Step Sequence No.7                  |            | Global |     |     |     |
| STEP_8           | BIT  | 1   | %M00008 | Step Sequence No.8                  |            | Global |     |     |     |
| STEP_9           | BIT  | 1   | %M00009 | Step Sequence No.9                  |            | Global |     |     |     |
| STEP_2_GE        | BIT  | 1   | %M00022 | Step Sequence No.2 GE               |            | Global |     |     |     |
| GEN_OFF          | BIT  | 1   | %M00101 | Generator OFF                       |            | Global |     |     |     |
| AUTO_TEST_STR    | BIT  | 1   | %M00102 | Auto Test Start / Stop              |            | Global |     |     |     |
| REMOTE_STR       | BIT  | 1   | %M00103 | Remote Start                        |            | Global |     |     |     |
| MAINS_FAIL_STP   | BIT  | 1   | %M00104 | Mains Failed Stop                   |            | Global |     |     |     |
| REMOTE_STP       | BIT  | 1   | %M00105 | Remote Stop                         |            | Global |     |     |     |
| TEST_STR         | BIT  | 1   | %M00106 | Test Start                          |            | Global |     |     |     |
| TEST_STP         | BIT  | 1   | %M00107 | Test Stop                           |            | Global |     |     |     |
| GEN_RUN_OFF      | BIT  | 1   | %M00108 | Generator Run Off                   |            | Global |     |     |     |
| ENABLE_OFFLINE   | BIT  | 1   | %M00109 | Enable Generator to go Offline      |            | Global |     |     |     |
| HH_ALM_OS1       | BIT  | 1   | %M00110 | High High Alarm One Shot            |            | Global |     |     |     |
| H_ALM_OS1        | BIT  | 1   | %M00111 | High Alarm One Shot                 |            | Global |     |     |     |
| H_ALM_OS2        | BIT  | 1   | %M00112 | High Alarm One Shot                 |            | Global |     |     |     |
| M_ALM_OS1        | BIT  | 1   | %M00113 | Medium Alarm One Shot               |            | Global |     |     |     |
| M_ALM_OS2        | BIT  | 1   | %M00114 | Medium Alarm One Shot               |            | Global |     |     |     |
| M_ATS_ALM_OS1    | BIT  | 1   | %M00115 | Mains ATS Alarm One Shot            |            | Global |     |     |     |
| M_ATS_ALM_OS2    | BIT  | 1   | %M00116 | Mains ATS Alarm One Shot            |            | Global |     |     |     |
| GEN_RUNNING      | BIT  | 1   | %M00201 | Generator Running                   |            | Global |     |     |     |
| FAIL_STR_TM      | BIT  | 1   | %M00202 | Failed to Start Time                |            | Global |     |     |     |
| FAIL_STR_DLY     | BIT  | 1   | %M00203 | Failed to Start Pulse Delay         |            | Global |     |     |     |
| FAIL_STR_CNT     | BIT  | 1   | %M00204 | Failed to Start Counter             |            | Global |     |     |     |
| CRK_CUTOUT       | BIT  | 1   | %M00205 | Generator Crank Cutout              |            | Global |     |     |     |
| ENB_STR_DLY      | BIT  | 1   | %M00206 | Enable Start Delay for Alarms       |            | Global |     |     |     |
| OIL_P_DLY        | BIT  | 1   | %M00207 | Oil Pressure Alarm Delay            |            | Global |     |     |     |
| STR_UP_DLY       | BIT  | 1   | %M00208 | Startup Alarm Delay                 |            | Global |     |     |     |

## GLOBAL VARIABLES

| Name               | Type | Len | Address | Description                               | Stored Val | Scope  | Ret | Ovr | Ext |
|--------------------|------|-----|---------|---|------------|--------|-----|-----|-----|
| M_ATS_OPN_1        | BIT  | 1   | %M00209 | Mains ATS Open Command                    |            | Global |     |     |     |
| G_ATS_CLS_1        | BIT  | 1   | %M00210 | Generator ATS Close Command               |            | Global |     |     |     |
| G_ATS_OPN_1        | BIT  | 1   | %M00211 | Generator ATS Open Command                |            | Global |     |     |     |
| M_ATS_CLS_1        | BIT  | 1   | %M00212 | Mains ATS Close Command                   |            | Global |     |     |     |
| M_ATS_CLS_ENB      | BIT  | 1   | %M00213 | Mains ATS Close Enable                    |            | Global |     |     |     |
| G_ATS_CLS_ENB      | BIT  | 1   | %M00214 | Generator ATS Close Enable                |            | Global |     |     |     |
| HIGH_HIGH_ALM      | BIT  | 1   | %M00300 | High High Alarm                           |            | Global |     |     |     |
| EM_STP_ALM         | BIT  | 1   | %M00301 | Emergency Stop Alarm                      |            | Global |     |     |     |
| MEN_ALM            | BIT  | 1   | %M00302 | MEN Alarm                                 |            | Global |     |     |     |
| OIL_P_SD_ALM       | BIT  | 1   | %M00303 | Low Oil Pressure Shutdown Alarm           |            | Global |     |     |     |
| ENG_T_SD_ALM       | BIT  | 1   | %M00304 | High Engine Temperature Shutdown Alarm    |            | Global |     |     |     |
| RAD_WATER_LOW_ALM  | BIT  | 1   | %M00305 | Low Radiator Water Level Alarm            |            | Global |     |     |     |
| SPD_OVER_ALM       | BIT  | 1   | %M00306 | Over Speed Alarm                          |            | Global |     |     |     |
| RAD_WATER_LOW_DLY  | BIT  | 1   | %M00315 | Radiator Water Level Low Delay            |            | Global |     |     |     |
| SPD_OVER_DLY       | BIT  | 1   | %M00316 | Over Speed Delay Timer                    |            | Global | R   |     |     |
| HIGH_ALM           | BIT  | 1   | %M00320 | High Alarm                                |            | Global |     |     |     |
| SPD_UNDER_ALM      | BIT  | 1   | %M00321 | Under Speed Alarm                         |            | Global |     |     |     |
| VOLTS_UNDER_ALM    | BIT  | 1   | %M00322 | Alternator Voltage Under Alarm            |            | Global |     |     |     |
| VOLTS_OVER_ALM     | BIT  | 1   | %M00323 | Alternator Voltage Over Alarm             |            | Global |     |     |     |
| GEN_CB_TRIP_ALM    | BIT  | 1   | %M00324 | Generator CB Tripped Alarm                |            | Global |     |     |     |
| ALT_TEMP_ALM       | BIT  | 1   | %M00325 | Alternator High Temperature Alarm         |            | Global |     |     |     |
| SPD_UNDER_DLY      | BIT  | 1   | %M00331 | Under Speed Alarm Delay                   |            | Global |     |     |     |
| VOLTS_UNDER_DLY    | BIT  | 1   | %M00332 | Under Voltage Alarm Delay                 |            | Global |     |     |     |
| VOLTS_OVER_DLY     | BIT  | 1   | %M00333 | Over Voltage Alarm Delay                  |            | Global |     |     |     |
| MEDIUM_ALM         | BIT  | 1   | %M00340 | Medium Alarm                              |            | Global |     |     |     |
| FUEL_LEV_EMPTY_ALM | BIT  | 1   | %M00341 | Fuel Empty Alarm                          |            | Global |     |     |     |
| FAIL_TO_STR_ALM    | BIT  | 1   | %M00342 | Fail to Start Alarm                       |            | Global |     |     |     |
| FUEL_LEV_EMPTY_DLY | BIT  | 1   | %M00351 | Fuel Level Empty Alarm Delay              |            | Global |     |     |     |
| LOW_ALM            | BIT  | 1   | %M00360 | Low Alarm                                 |            | Global |     |     |     |
| OIL_P_W_ALM        | BIT  | 1   | %M00361 | Low Oil Pressure Warning Alarm            |            | Global |     |     |     |
| ENG_T_W_ALM        | BIT  | 1   | %M00362 | High Engine Temperature Warning Alarm     |            | Global |     |     |     |
| FUEL_LEV_LOW_ALM   | BIT  | 1   | %M00363 | Low Fuel Level Alarm                      |            | Global |     |     |     |
| BAT_CHG_AC_ALM     | BIT  | 1   | %M00364 | Battery Charger AC Alarm                  |            | Global |     |     |     |
| BAT_CONT_LOW_V_ALM | BIT  | 1   | %M00365 | Control Battery Charger Low Voltage Alarm |            | Global |     |     |     |
| BAT_STR_LOW_V_ALM  | BIT  | 1   | %M00366 | Start Battery Charger Low Voltage Alarm   |            | Global |     |     |     |
| FUEL_LEV_LOW_DLY   | BIT  | 1   | %M00373 | Fuel Level Low Alarm Delay                |            | Global | R   |     |     |
| BAT_CHG_AC_DLY     | BIT  | 1   | %M00374 | Battery Charger AC Failure Delay          |            | Global | R   |     |     |
| BAT_CONT_LOW_V_DLY | BIT  | 1   | %M00375 | Control Battery Low Voltage Delay         |            | Global | R   |     |     |
| BAT_STR_LOW_V_DLY  | BIT  | 1   | %M00376 | Start Battery Low Voltage Delay           |            | Global | R   |     |     |
| MAINS_ATS_OPN_ALM  | BIT  | 1   | %M00381 | Mains ATS Failed to Open Alarm            |            | Global |     |     |     |
| MAINS_ATS_CLS_ALM  | BIT  | 1   | %M00382 | Mains ATS Failed to Close Alarm           |            | Global |     |     |     |
| GEN_ATS_OPN_ALM    | BIT  | 1   | %M00383 | Generator ATS Failed to Open Alarm        |            | Global |     |     |     |
| GEN_ATS_CLS_ALM    | BIT  | 1   | %M00384 | Generator ATS Failed to Close Alarm       |            | Global |     |     |     |
| NEW_ALM            | BIT  | 1   | %M00400 | New Alarm                                 |            | Global | R   |     |     |
| %M00401            | BIT  | 1   | %M00401 | **No Description**                        |            | Global | R   |     |     |
| %M00402            | BIT  | 1   | %M00402 | **No Description**                        |            | Global | R   |     |     |
| %M00403            | BIT  | 1   | %M00403 | **No Description**                        |            | Global | R   |     |     |
| %M00404            | BIT  | 1   | %M00404 | **No Description**                        |            | Global | R   |     |     |
| %M00405            | BIT  | 1   | %M00405 | **No Description**                        |            | Global | R   |     |     |
| %M00406            | BIT  | 1   | %M00406 | **No Description**                        |            | Global | R   |     |     |
| %M00421            | BIT  | 1   | %M00421 | **No Description**                        |            | Global | R   |     |     |
| %M00422            | BIT  | 1   | %M00422 | **No Description**                        |            | Global | R   |     |     |
| %M00423            | BIT  | 1   | %M00423 | **No Description**                        |            | Global | R   |     |     |
| %M00424            | BIT  | 1   | %M00424 | **No Description**                        |            | Global | R   |     |     |
| %M00425            | BIT  | 1   | %M00425 | **No Description**                        |            | Global | R   |     |     |

## GLOBAL VARIABLES

| Name               | Type | Len | Address | Description                                   | Stored Val | Scope  | Ret | Ovr | Ext |
|--------------------|------|-----|---------|---|------------|--------|-----|-----|-----|
| %N 41              | BIT  | 1   | %M00441 | **No Description**                            |            | Global | R   |     |     |
| %N 42              | BIT  | 1   | %M00442 | **No Description**                            |            | Global | R   |     |     |
| %M00461            | BIT  | 1   | %M00461 | **No Description**                            |            | Global | R   |     |     |
| %M00462            | BIT  | 1   | %M00462 | **No Description**                            |            | Global | R   |     |     |
| %M00463            | BIT  | 1   | %M00463 | **No Description**                            |            | Global | R   |     |     |
| %M00464            | BIT  | 1   | %M00464 | **No Description**                            |            | Global | R   |     |     |
| %M00465            | BIT  | 1   | %M00465 | **No Description**                            |            | Global | R   |     |     |
| %M00466            | BIT  | 1   | %M00466 | **No Description**                            |            | Global | R   |     |     |
| %M00481            | BIT  | 1   | %M00481 | **No Description**                            |            | Global | R   |     |     |
| %M00482            | BIT  | 1   | %M00482 | **No Description**                            |            | Global | R   |     |     |
| %M00483            | BIT  | 1   | %M00483 | **No Description**                            |            | Global | R   |     |     |
| %M00484            | BIT  | 1   | %M00484 | **No Description**                            |            | Global | R   |     |     |
| AUTO_IND           | BIT  | 1   | %Q00001 | Controls in Auto Indicator                    |            | Global |     |     |     |
| TEST_IND           | BIT  | 1   | %Q00002 | Controls in Test Indicator                    |            | Global |     |     |     |
| MAN_IND            | BIT  | 1   | %Q00003 | Controls in Manual Indicator                  |            | Global |     |     |     |
| REM_STR_IND        | BIT  | 1   | %Q00004 | Remote Start Indicator                        |            | Global |     |     |     |
| MAINS_AVAIL_IND    | BIT  | 1   | %Q00005 | Mains Available Indicator                     |            | Global |     |     |     |
| MAINS_CON_IND      | BIT  | 1   | %Q00006 | Mains Connected Indicator                     |            | Global |     |     |     |
| GEN_RUN_IND        | BIT  | 1   | %Q00007 | Generator Running Indicator                   |            | Global |     |     |     |
| GEN_CON_IND        | BIT  | 1   | %Q00008 | Generator Connected Indicator                 |            | Global |     |     |     |
| MAINS_FAILED_IND   | BIT  | 1   | %Q00009 | Mains Failed Indicator                        |            | Global |     |     |     |
| EM_STOP_IND        | BIT  | 1   | %Q00010 | Emergency Stop Indicator                      |            | Global |     |     |     |
| MEN_FAULT_IND      | BIT  | 1   | %Q00011 | MEN Fault Indicator                           |            | Global |     |     |     |
| OIL_LOW_SD_IND     | BIT  | 1   | %Q00012 | Low Oil Pressure Shutdown Indicator           |            | Global |     |     |     |
| OIL_P_LOW_W_IND    | BIT  | 1   | %Q00013 | Low Oil Pressure Warning Indicator            |            | Global |     |     |     |
| ENG_T_HI_SD_IND    | BIT  | 1   | %Q00014 | High Engine Temperature Shutdown Indicator    |            | Global |     |     |     |
| ENG_T_HI_W_IND     | BIT  | 1   | %Q00015 | High Engine Temperature Warning Indicator     |            | Global |     |     |     |
| RAD_WATER_LOW_IND  | BIT  | 1   | %Q00016 | Low Radiator Water Level Indicator            |            | Global |     |     |     |
| FUEL_LEV_EMPTY_IND | BIT  | 1   | %Q00017 | Fuel Empty Indicator                          |            | Global |     |     |     |
| FUEL_LEV_LOW_IND   | BIT  | 1   | %Q00018 | Low Fuel Level Indicator                      |            | Global |     |     |     |
| SPD_OVER_IND       | BIT  | 1   | %Q00019 | Over Speed Indicator                          |            | Global |     |     |     |
| SPD_UNDER_IND      | BIT  | 1   | %Q00020 | Under Speed Indicator                         |            | Global |     |     |     |
| FAIL_TO_STR_IND    | BIT  | 1   | %Q00021 | Fail to Start Indicator                       |            | Global |     |     |     |
| VOLTS_UNDER_IND    | BIT  | 1   | %Q00022 | Alternator Voltage Under Indicator            |            | Global |     |     |     |
| VOLTS_OVER_IND     | BIT  | 1   | %Q00023 | Alternator Voltage Over Indicator             |            | Global |     |     |     |
| ALT_TEMP_IND       | BIT  | 1   | %Q00024 | Alternator High Temperature Indicator         |            | Global |     |     |     |
| GEN_CB_TRIP_IND    | BIT  | 1   | %Q00025 | Generator CB Tripped Indicator                |            | Global |     |     |     |
| BAT_CHG_AC_IND     | BIT  | 1   | %Q00026 | Battery Charger AC Indicator                  |            | Global |     |     |     |
| BAT_CONT_LOW_V_IND | BIT  | 1   | %Q00027 | Control Battery Charger Low Voltage Indicator |            | Global |     |     |     |
| BAT_STR_LOW_V_IND  | BIT  | 1   | %Q00028 | Start Battery Charger Low Voltage Indicator   |            | Global |     |     |     |
| CAN_DOORS_OPEN_IND | BIT  | 1   | %Q00029 | Canopy Doors Open Indicator                   |            | Global |     |     |     |
| MAINS_ATS_OPN_CMD  | BIT  | 1   | %Q00033 | BCC Mains ATS Open Command                    |            | Global |     |     |     |
| GEN_ATS_CLS_CMD    | BIT  | 1   | %Q00034 | BCC Generator ATS Close Command               |            | Global |     |     |     |
| GEN_SD_ALM         | BIT  | 1   | %Q00035 | BCC Generator Shutdown Alarm                  |            | Global |     |     |     |
| GEN_W_ALM          | BIT  | 1   | %Q00036 | BCC Generator Warning Alarm                   |            | Global |     |     |     |
| FUEL_LOW           | BIT  | 1   | %Q00037 | BCC Low Fuel                                  |            | Global |     |     |     |
| GEN_RUN            | BIT  | 1   | %Q00038 | BCC Generator Running                         |            | Global |     |     |     |
| GEN_CON            | BIT  | 1   | %Q00039 | BCC Generator Connected                       |            | Global |     |     |     |
| SMR                | BIT  | 1   | %Q00040 | Starter Motor Relay                           |            | Global |     |     |     |
| GCR                | BIT  | 1   | %Q00041 | Governor Control Relay                        |            | Global |     |     |     |
| AAR                | BIT  | 1   | %Q00042 | Audible Alarm Relay                           |            | Global |     |     |     |
| SDAR               | BIT  | 1   | %Q00043 | Generator Shunt Trip Relay                    |            | Global |     |     |     |
| SEQ_CNT            | WORD | 1   | %R00001 | Sequence Counter                              |            | Global | R   |     |     |
| MODBUS_INPUTS      | WORD | 1   | %R00002 | Modbus Digital Inputs                         |            | Global | R   |     |     |
| MODBUS_OUTPUTS     | WORD | 1   | %R00005 | Modbus Digital Outputs                        |            | Global | R   |     |     |
| MODBUS_STATUS_1    | WORD | 1   | %R00008 | Modbus Status 1                               |            | Global | R   |     |     |
| MODBUS_STATUS_2    | WORD | 1   | %R00009 | Modbus Status 2                               |            | Global | R   |     |     |
| MODBUS_ALARMS      | WORD | 1   | %R00010 | Modbus Alarms                                 |            | Global | R   |     |     |
| %R00100            | WORD | 3   | %R00100 | **No Description**                            |            | Global | R   |     |     |
| %R00103            | WORD | 3   | %R00103 | **No Description**                            |            | Global | R   |     |     |

## GLOBAL VARIABLES

| Name     | Type | Len | Address | Description  | Stored Val | Scope  | Ret | Ovr | Ext |
|----------|------|-----|---------|--|------------|--------|-----|-----|-----|
| %R00106  | WORD | 3   | %R00106 | **No Description**   |            | Global | R   |     |     |
| %R00109  | WORD | 3   | %R00109 | **No Description**   |            | Global | R   |     |     |
| %R00112  | WORD | 3   | %R00112 | **No Description**   |            | Global | R   |     |     |
| %R00115  | WORD | 3   | %R00115 | **No Description**   |            | Global | R   |     |     |
| %R00118  | WORD | 3   | %R00118 | **No Description**   |            | Global | R   |     |     |
| %R00121  | WORD | 3   | %R00121 | **No Description**   |            | Global | R   |     |     |
| %R00124  | WORD | 3   | %R00124 | **No Description**   |            | Global | R   |     |     |
| %R00127  | WORD | 3   | %R00127 | **No Description**   |            | Global | R   |     |     |
| %R00130  | WORD | 3   | %R00130 | **No Description**   |            | Global | R   |     |     |
| %R00200  | WORD | 3   | %R00200 | **No Description**   |            | Global | R   |     |     |
| %R00203  | WORD | 3   | %R00203 | **No Description**   |            | Global | R   |     |     |
| %R00206  | WORD | 3   | %R00206 | **No Description**   |            | Global | R   |     |     |
| %R00209  | WORD | 3   | %R00209 | **No Description**   |            | Global | R   |     |     |
| %R00212  | WORD | 3   | %R00212 | **No Description**   |            | Global | R   |     |     |
| %R00215  | WORD | 3   | %R00215 | **No Description**   |            | Global | R   |     |     |
| %R00218  | WORD | 3   | %R00218 | **No Description**   |            | Global | R   |     |     |
| %R00221  | WORD | 3   | %R00221 | **No Description**   |            | Global | R   |     |     |
| %R00224  | WORD | 3   | %R00224 | **No Description**   |            | Global | R   |     |     |
| %R00227  | WORD | 3   | %R00227 | **No Description**   |            | Global | R   |     |     |
| %R00230  | WORD | 3   | %R00230 | **No Description**   |            | Global | R   |     |     |
| %R00300  | WORD | 3   | %R00300 | **No Description**   |            | Global | R   |     |     |
| %R00303  | WORD | 3   | %R00303 | **No Description**   |            | Global | R   |     |     |
| %R00306  | WORD | 3   | %R00306 | **No Description**   |            | Global | R   |     |     |
| %R00309  | WORD | 3   | %R00309 | **No Description**   |            | Global | R   |     |     |
| %R00312  | WORD | 3   | %R00312 | **No Description**   |            | Global | R   |     |     |
| %R00315  | WORD | 3   | %R00315 | **No Description**   |            | Global | R   |     |     |
| %R00318  | WORD | 3   | %R00318 | **No Description**   |            | Global | R   |     |     |
| %R00321  | WORD | 3   | %R00321 | **No Description**   |            | Global | R   |     |     |
| %R00324  | WORD | 3   | %R00324 | **No Description**   |            | Global | R   |     |     |
| %R00327  | WORD | 3   | %R00327 | **No Description**   |            | Global | R   |     |     |
| %R00330  | WORD | 3   | %R00330 | **No Description**   |            | Global | R   |     |     |
| %R00333  | WORD | 3   | %R00333 | **No Description**   |            | Global | R   |     |     |
| %R00336  | WORD | 3   | %R00336 | **No Description**   |            | Global | R   |     |     |
| %R00339  | WORD | 3   | %R00339 | **No Description**   |            | Global | R   |     |     |
| FST_SCN  | BIT  | 1   | %S00001 | Set to 1 when the current sweep is the first sweep         |            | Global | R   |     |     |
| LST_SCAN | BIT  | 1   | %S00002 | Reset from 1 to 0 when the current sweep is the last sweep |            | Global | R   |     |     |
| T_10MS   | BIT  | 1   | %S00003 | 0.01 Second Timer Contact                                  |            | Global | R   |     |     |
| T_100MS  | BIT  | 1   | %S00004 | 0.1 Second Timer Contact                                   |            | Global | R   |     |     |
| T_1S     | BIT  | 1   | %S00005 | 1 Second Timer Contact                                     |            | Global | R   |     |     |
| T_1M     | BIT  | 1   | %S00006 | 1 Minute Timer Contact                                     |            | Global | R   |     |     |
| ALW_ON   | BIT  | 1   | %S00007 | Always ON  |            | Global | R   |     |     |
| ALW_OFF  | BIT  | 1   | %S00008 | Always OFF   |            | Global | R   |     |     |
| PLC_BAT  | BIT  | 1   | %S00014 | Set to indicate a bad battery in the CPU                   |            | Global | R   |     |     |
| %R00133  | WORD | 3   | %R00133 | **No Description**   |            | Global | R   |     |     |
| %R00136  | WORD | 3   | %R00136 | **No Description**   |            | Global | R   |     |     |

**GLOBAL SUMMARY OF HIGHEST USED REFERENCE ADDRESSES**

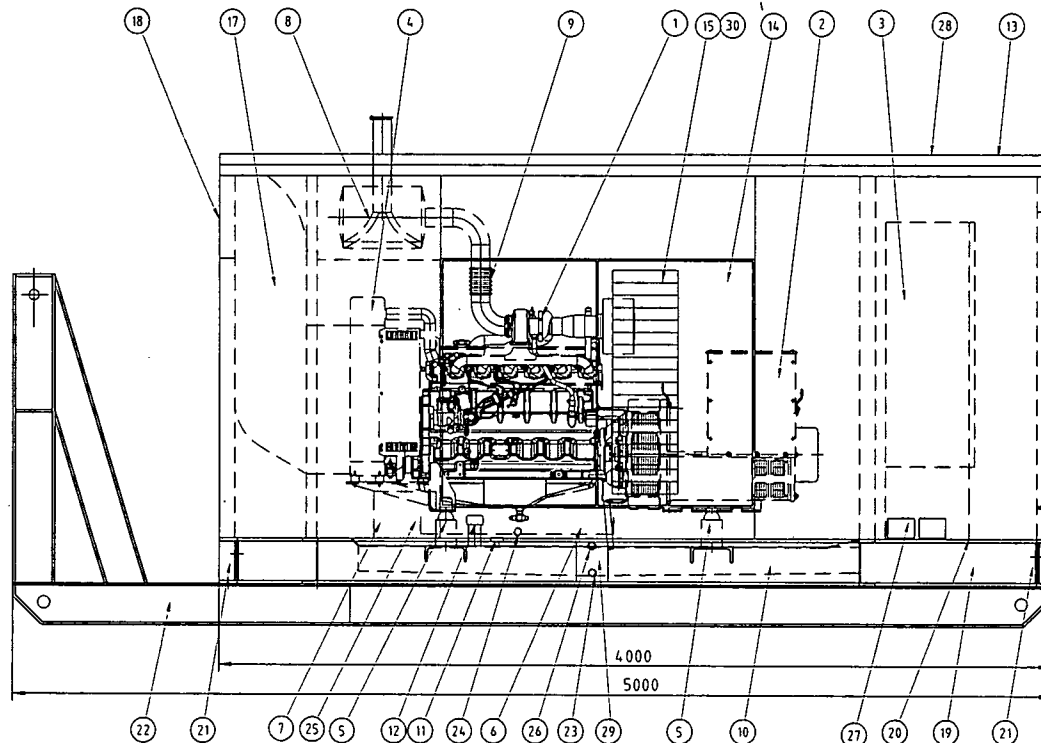
| <b>MEMORY AREA</b>   | <b>ADDRESS</b> |
|----------------------|----------------|
| Analog Input (%AI)   | None Used      |
| Analog Output (%AQ)  | None Used      |
| Input (%I)           | %I00048        |
| Output (%Q)          | %Q00048        |
| Internal Memory (%M) | %M00484        |
| Register (%R)        | %R00341        |
| Genius Global (%G)   | None Used      |
| Genius Global (%GA)  | None Used      |
| Genius Global (%GB)  | None Used      |
| Genius Global (%GC)  | None Used      |
| Genius Global (%GD)  | None Used      |
| Genius Global (%GE)  | None Used      |
| Temporary (%T)       | None Used      |
| System (%S)          | %S00007        |
| System (%SA)         | None Used      |
| System (%SB)         | None Used      |
| System (%SC)         | None Used      |
| Program (%P)         | None Used      |

## Table of Contents

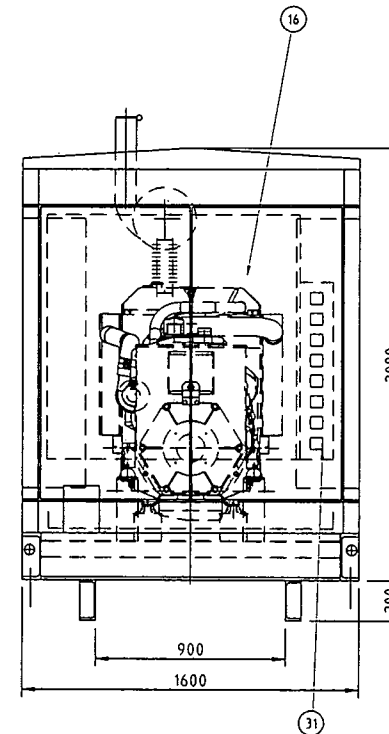
|  |    |
|--|----|
| Block: AUD_ALM.blk                               |    |
| Properties.....                                  | 2  |
| Logic.....                                       | 3  |
| Block: ALARM.blk                                 |    |
| Properties.....                                  | 7  |
| Logic.....                                       | 8  |
| Block: SEQ.blk                                   |    |
| Properties.....                                  | 19 |
| Logic.....                                       | 20 |
| Block: MAIN.blk                                  |    |
| Properties.....                                  | 29 |
| Logic.....                                       | 30 |
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| Properties.....                                  | 39 |
| Logic.....                                       | 40 |
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| Properties.....                                  | 41 |
| Logic.....                                       | 42 |
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SIDE ELEVATION



ALTERNATOR END ELEVATION

| LEGEND |                                    |
|--------|------------------------------------|
| ITEM   | DESCRIPTION                        |
| 1      | ENGINE JOHN DEERE 606BT            |
| 2      | ALTERNATOR STAMFORD UC274E         |
| 3      | CONTROL SWITCHBOARD                |
| 4      | RADIATOR                           |
| 5      | A/V MOUNTS (4 OFF)                 |
| 6      | ENGINE DRIP TRAY                   |
| 7      | STARTING BATTERY (382)             |
| 8      | EXHAUST SILENCER (COWL TS30PR)     |
| 9      | EXHAUST PIPE FLEXIBLE Ø75          |
| 10     | FUEL TANK BASE FRAME 400 L         |
| 11     | FUEL GAUGE (MECHANICAL)            |
| 12     | FUEL FILL POINT (INSIDE ENCLOSURE) |
| 13     | ACOUSTIC ENCLOSURE (70dbA @ 7m)    |
| 14     | SIDE ACCESS DOORS (2 OFF)          |
| 15     | AIR INLET GRILL                    |
| 16     | SWITCHBOARD ACCESS DOOR            |
| 17     | PLENUM CHAMBER                     |
| 18     | AIR OUTLET GRILL                   |
| 19     | CABLE ENTRY ZONE                   |
| 20     | ANCHOR POINT                       |
| 21     | LIFTING POINTS                     |
| 22     | TRANSPORT SKID                     |
| 23     | FUEL TANK DRAIN (LOCKABLE)         |
| 24     | OIL DRAIN (LOCKABLE)               |
| 25     | RADIATOR DRAIN HOSE                |
| 26     | CATCHMENT TRAY DRAIN               |
| 27     | CONTROL BATTERIES (2x12 VOLT)      |
| 28     | BATTERY CHARGING SOLAR PANEL       |
| 29     | DRAIN POINT LOCKABLE COVER         |
| 30     | INSECT SCREEN                      |
| 31     | OUTPUT & CONTROL SOCKETS T.B.A.    |

## NOTE

ENCLOSURE COLOUR : MIST GREEN

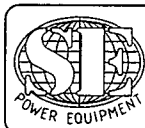
BASE TANK COLOUR : MIST GREEN

SKID BASE COLOUR : MIST GREEN

**APPROVED FOR  
CONSTRUCTION**

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| Rev. | Date   | DESIGN REVIEW | REV'D P.MGR | APP'D P.MGR | Amendment              |
|------|--------|---------------|-------------|-------------|------------------------|
| 0    | 2.6.03 |               |             |             | ISSUE FOR CONSTRUCTION |
| A    | 2.5.03 |               |             |             | APPROVAL ISSUE         |

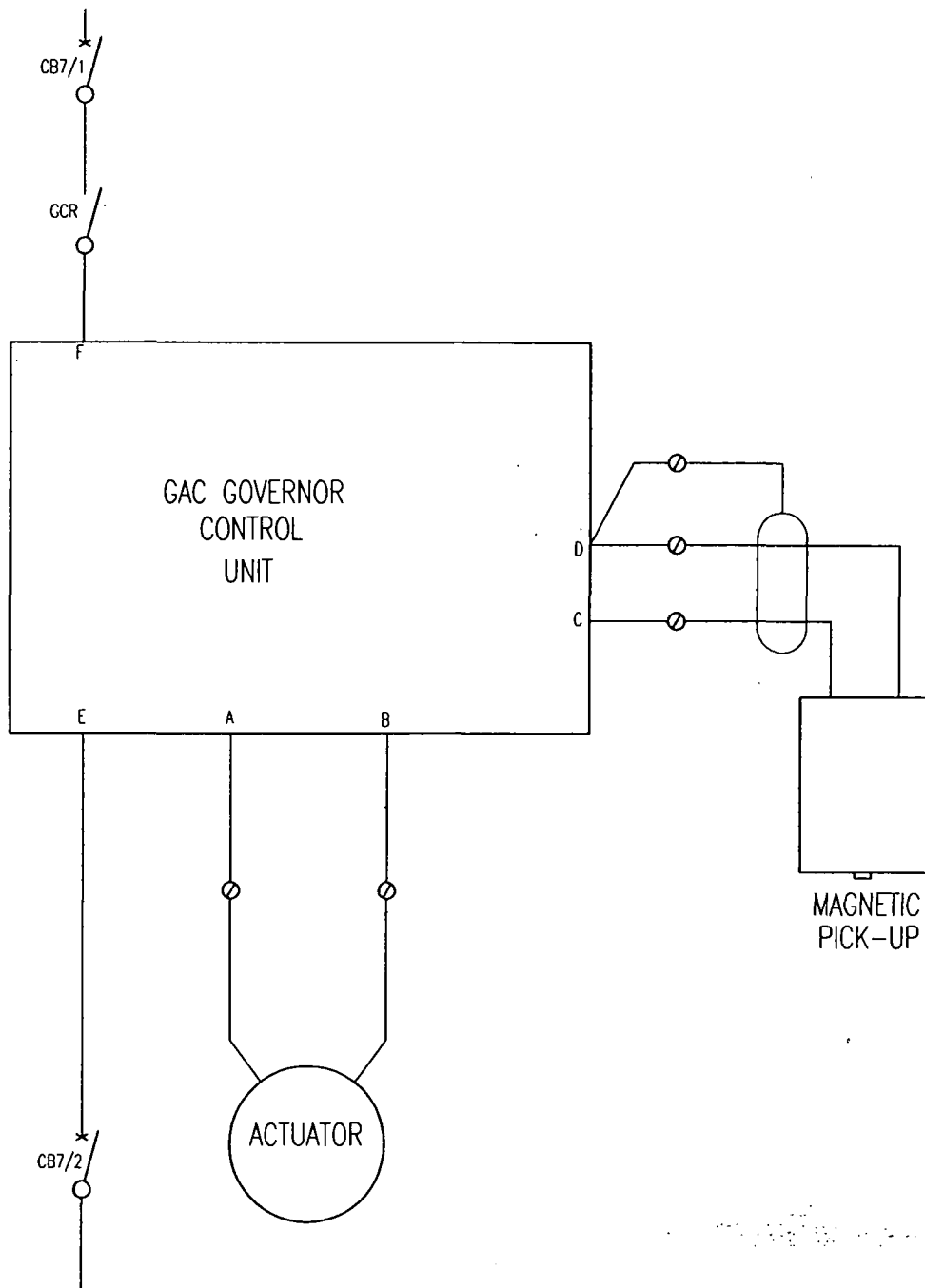


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Facsimile: (07) 3390 4631

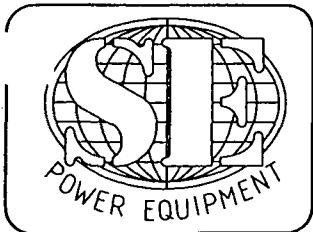
|  |               |                             |                              |
|--|---------------|-----------------------------|------------------------------|
| Client<br>BRISBANE WATER                     |               |                             |                              |
| Project<br>SEWAGE PUMP STATION BACKUP GENSET |               |                             |                              |
| Drafter<br>RSL                               | Draft Check   | Reviewed<br>Project Manager | Approved<br>Project Director |
| Designed<br>RSL                              | Design Review |                             |                              |

|   |                                |                     |            |                               |
|---|--------------------------------|---------------------|------------|-------------------------------|
| Title<br>SP078 SANDGATE ROAD<br>ARRANGEMENT |                                |                     |            |                               |
| Scale<br>1:20                               | No in set<br>1                 | SE Ref No.<br>16291 | SE Job No. | S.E. Drawing No.<br>14291-007 |
| Engineer's Ref. No.                         | Client Ref. No.<br>30140-02/03 |                     |            | AMD<br>0                      |



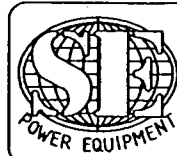


0 1.8.03 AS BUILT



|  |  |                          |                           |                  |
|--|--|--------------------------|---------------------------|------------------|
| EQUIPMENT DATA SHEET   |  | REV No:<br>0             | PROJECT No:<br>14291-605  | DATE:<br>1.08.03 |
| TITLE: BCC BRISBANE WATER<br>PUMP STATION BACKUP GENSET<br>GAC GOVERNOR CONTROLS |  | REF:                     | PREPARED<br>BY: HJR / RSL | CHECKED<br>BY:   |
|  |  | APPROVED FOR ISSUE<br>JP |                           | SCALE:<br>1:1    |

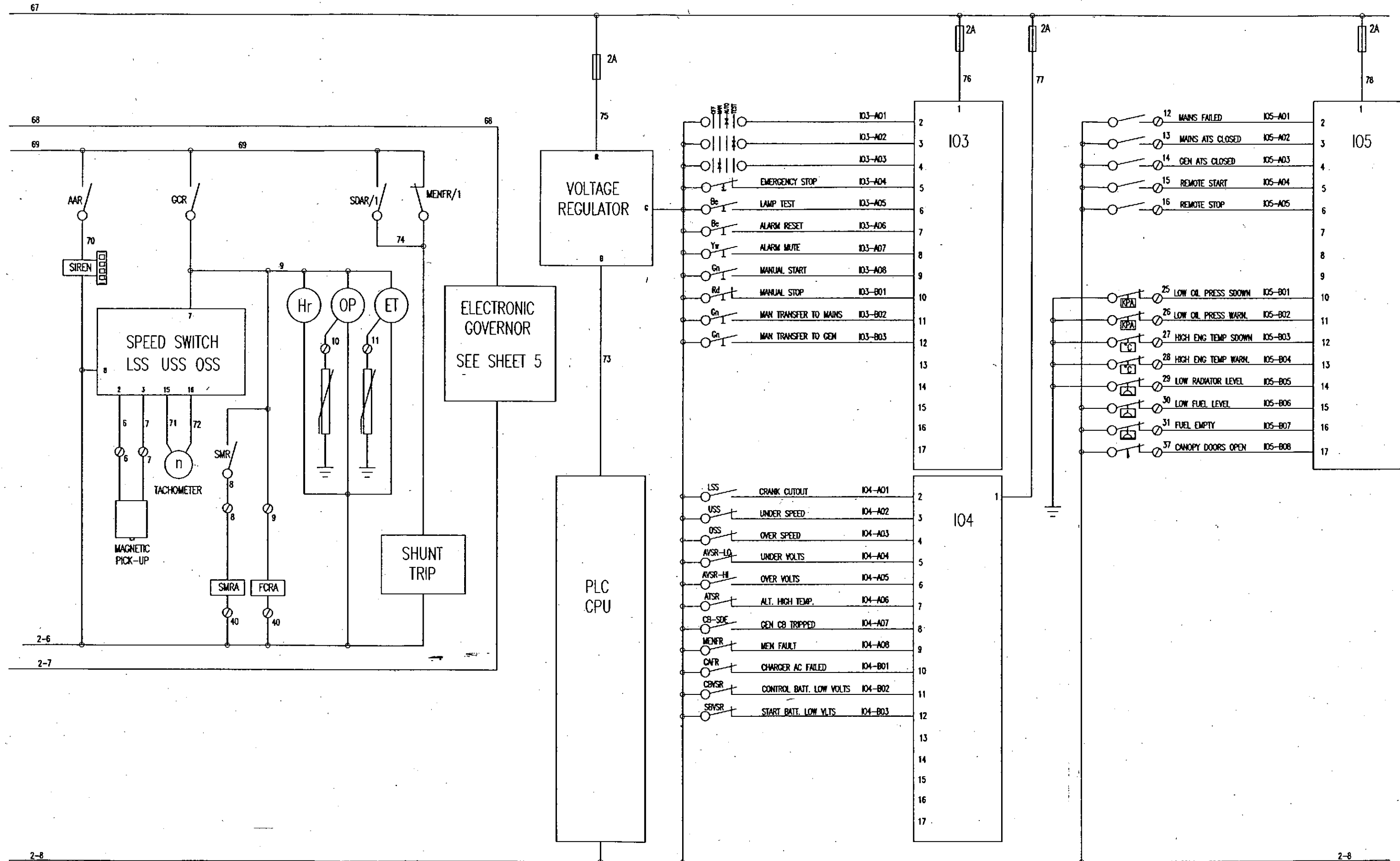




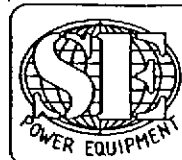
Active T0/12/2014

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| No | DATE     | DESIGN | REV'D | APPT | AMENDMENT        |
|----|----------|--------|-------|------|------------------|
| C  | 1-8-03   |        |       |      | AS BUILT         |
| B  | 15-05-03 |        |       |      | DRIVING FINISHED |
| A  | 08-05-03 |        |       |      | NEW DRAWING      |

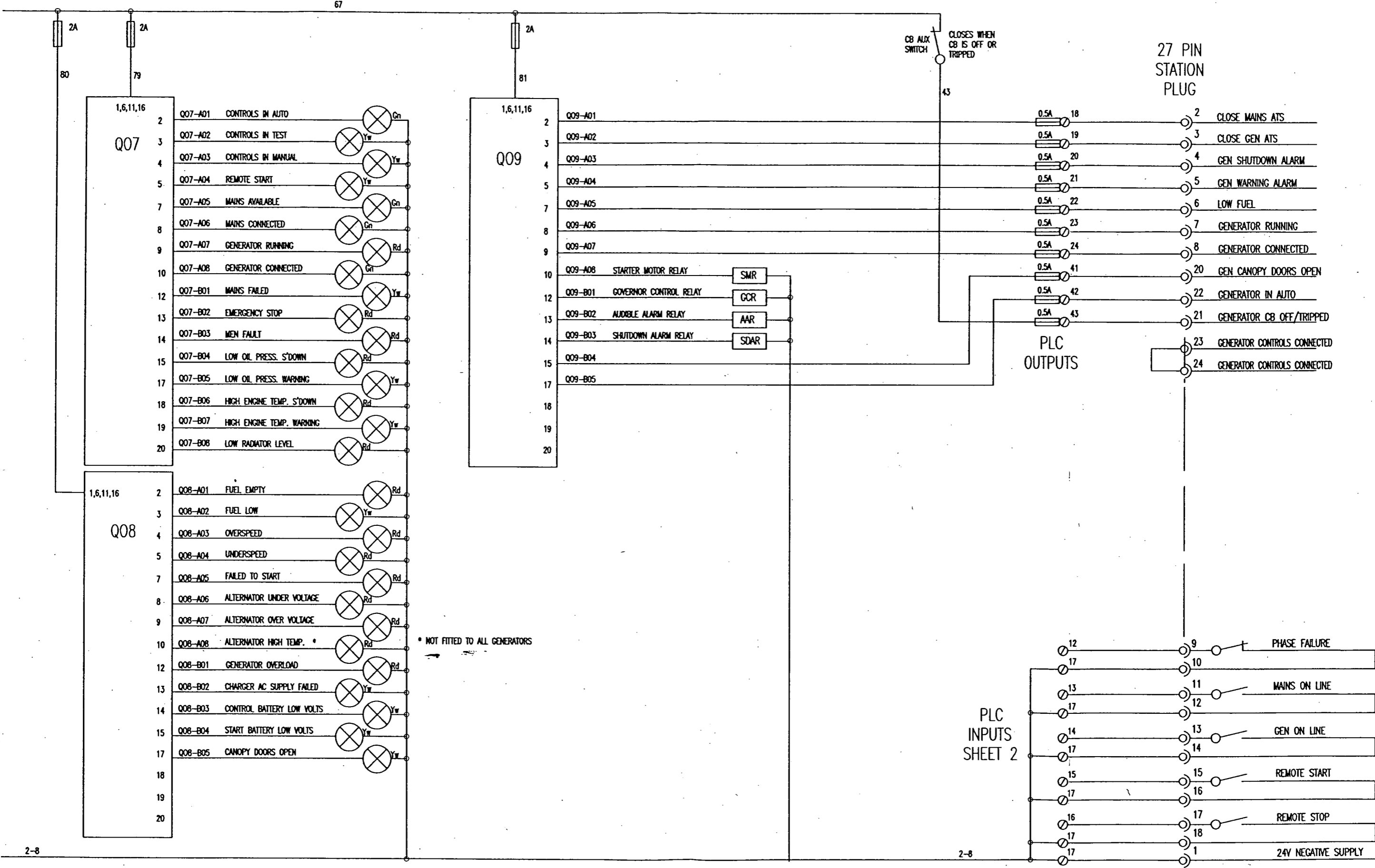


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|          |                        |                |                 |
|----------|------------------------|----------------|-----------------|
| CLIENT   | B.C.C. BRISBANE WATER  |                |                 |
| PROJECT  | PUMP STATION GENERATOR |                |                 |
| DRAFTER  | HJR                    | DRAFTING CHECK | EPAC JOB NUMBER |
| DESIGNED | HJR                    | DESIGN REVIEW  | 4000            |
|          |                        |                | 28396           |

|       |                                |            |          |
|-------|--------------------------------|------------|----------|
| TITLE | GENERATOR ELECTRICAL SCHEMATIC |            |          |
| SCALE | NTS                            | DRAWING No | 14291-02 |
|       |                                | No IN SET  | 2 of 5   |





|    |          |               |             |             |   |
|----|----------|---------------|-------------|-------------|---|
| E  | 10-05-04 |               |             |             | 27 PIN PLUG REMOTE CONNECTIONS WERE CHANGED TO MATCH SIZE WIRING AS BUILT |
| D  | 01-08-03 |               |             |             | EXTRA REMOTE ALARMS WERE ADDED  |
| C  | 23-07-03 |               |             |             | DRAWING FINISHED  |
| B  | 15-05-03 |               |             |             | NEW DRAWING   |
| A  | 08-05-03 |               |             |             | AMENDMENT   |
| No | DATE     | DESIGN REVIEW | REV'D P.NGR | APP'D P.NGR |   |

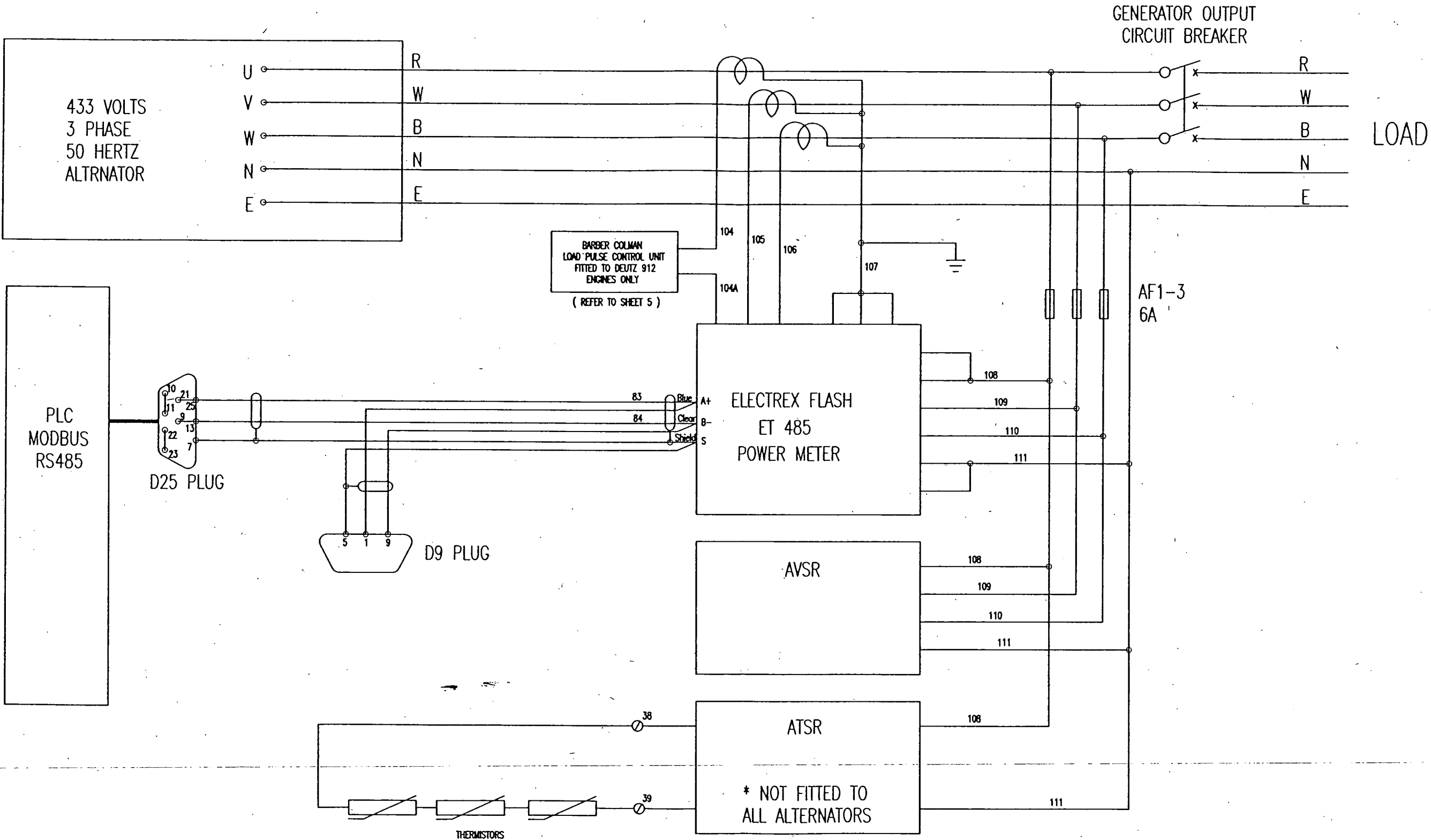


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|                     |                        |
|---------------------|------------------------|
| CLIENT              | B.C.C. BRISBANE WATER  |
| PROJECT             | PUMP STATION GENERATOR |
| DRAFTER             | HJR                    |
| DESIGNED            | HJR                    |
| DRAFTING CHECK      |                        |
| DESIGN REVIEW       |                        |
| EPAC JOB NUMBER     | 4000                   |
| SE POWER JOB NUMBER | 28396                  |

|            |                                |
|------------|--------------------------------|
| TITLE      | GENERATOR ELECTRICAL SCHEMATIC |
| SCALE      | NTS                            |
| DRAWING No | 14291-02                       |
| No IN SET  | 3 of 5                         |
| AMDT       | E                              |





| No | DATE     | DESIGN REVIEW | REV'D P. NO | APP'D P. NO | AMENDMENT        |
|----|----------|---------------|-------------|-------------|------------------|
| C  | 11-9-03  |               |             |             | AS BUILT         |
| B  | 15-05-03 |               |             |             | DRAWING FINISHED |
| A  | 08-05-03 |               |             |             | NEW DRAWING      |

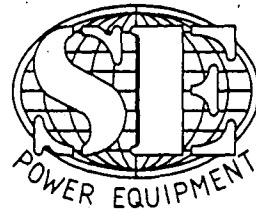
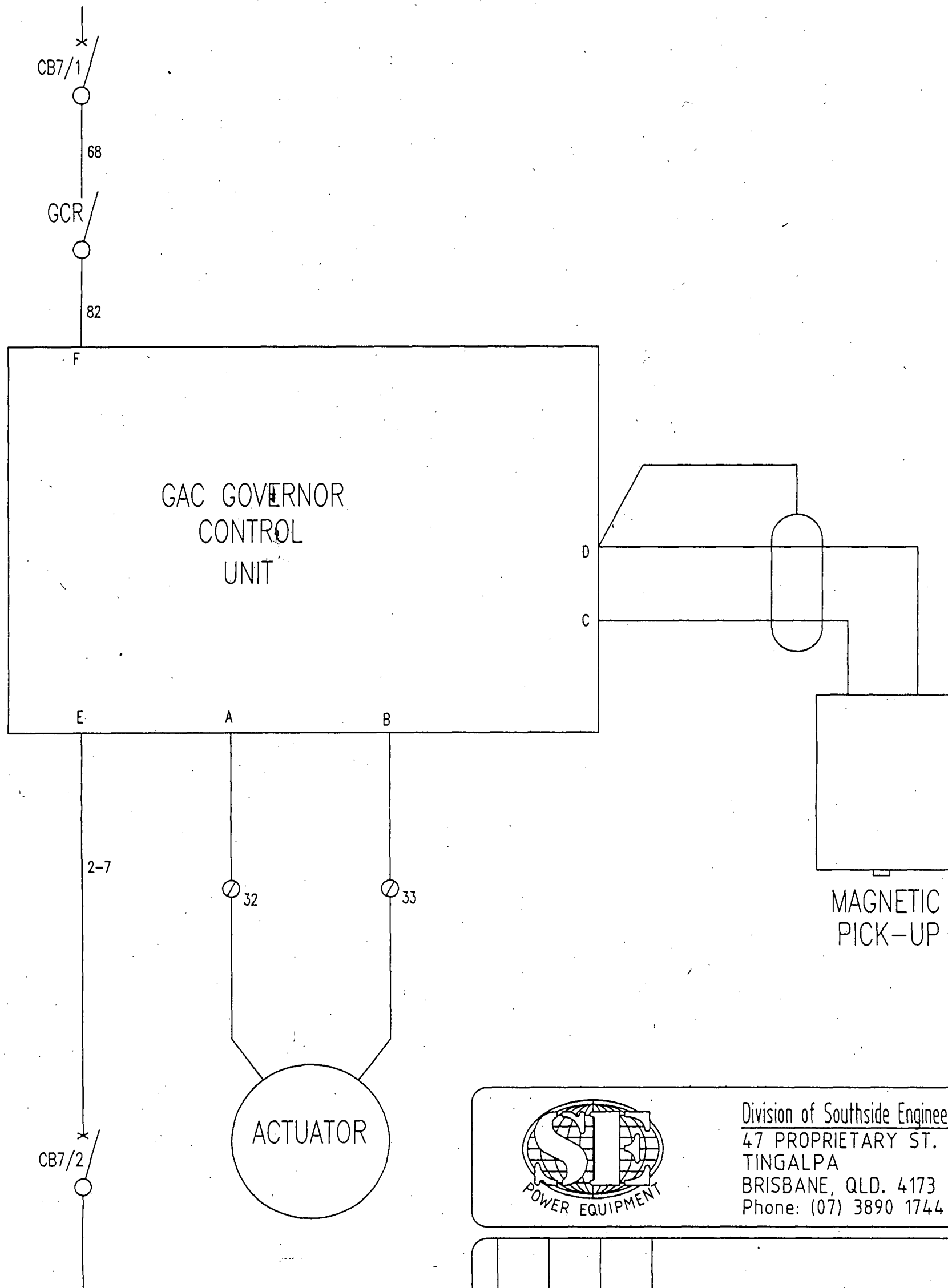


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|                                   |                                 |                            |                                 |
|-----------------------------------|---------------------------------|----------------------------|---------------------------------|
| CLIENT<br>B.C.C. BRISBANE WATER   |                                 |                            |                                 |
| PROJECT<br>PUMP STATION GENERATOR |                                 |                            |                                 |
| DRAFTER<br>HJR                    | DRAFTING CHECK<br>DESIGN REVIEW | EPAC<br>JOB NUMBER<br>4000 | SE POWER<br>JOB NUMBER<br>28396 |

|                               |                        |                     |           |
|-------------------------------|------------------------|---------------------|-----------|
| TITLE<br>ELECTRICAL SCHEMATIC |                        |                     |           |
| SCALE<br>NTS                  | DRAWING No<br>14291-02 | No IN SET<br>4 of 5 | AMDT<br>C |





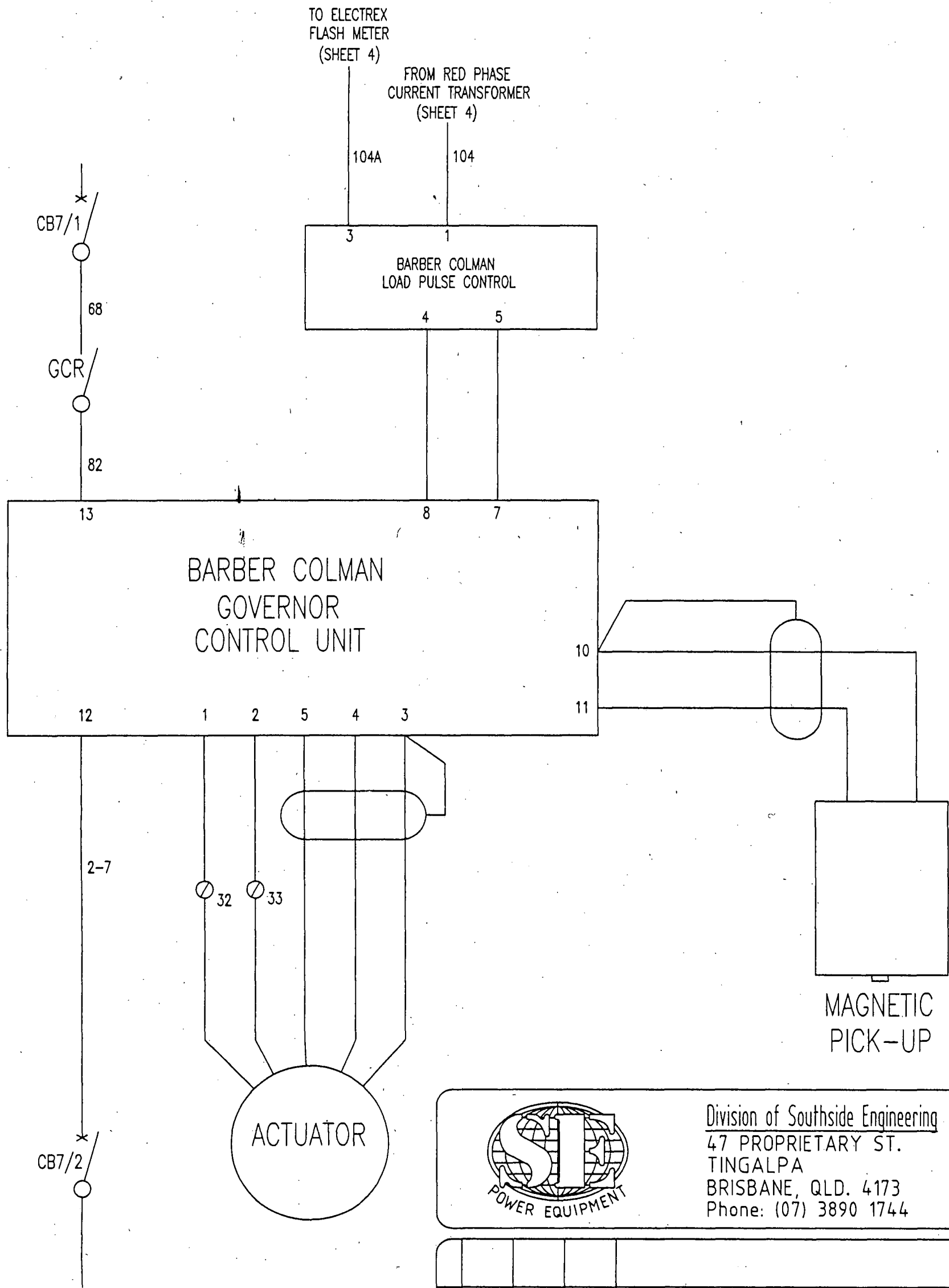
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| No | DATE     | DESIGN REVIEW | REV'D P.MGR | AMENDMENT         |
|----|----------|---------------|-------------|-------------------|
| C  | 1-9-03   |               |             | AS BUILT          |
| B  | 15-05-03 |               |             | DRAWING FINALISED |
| A  | 08-05-03 |               |             | NEW DRAWING       |

|                 |                        |                    |                        |
|-----------------|------------------------|--------------------|------------------------|
| CLIENT          | B.C.C. BRISBANE WATER  |                    |                        |
| PROJECT         | PUMP STATION GENERATOR |                    |                        |
| DRAFTER<br>HJR  | DRAFTING CHECK         | EPAC<br>JOB NUMBER | SE POWER<br>JOB NUMBER |
| DESIGNED<br>HJR | DESIGN REVIEW          | 4000               | 28396                  |

|              |                        |                     |           |
|--------------|------------------------|---------------------|-----------|
| TITLE        | GAC GOVERNOR CONTROLS  |                     |           |
| SCALE<br>NTS | DRAWING No<br>14291-02 | No IN SET<br>5 of 5 | AMDT<br>C |





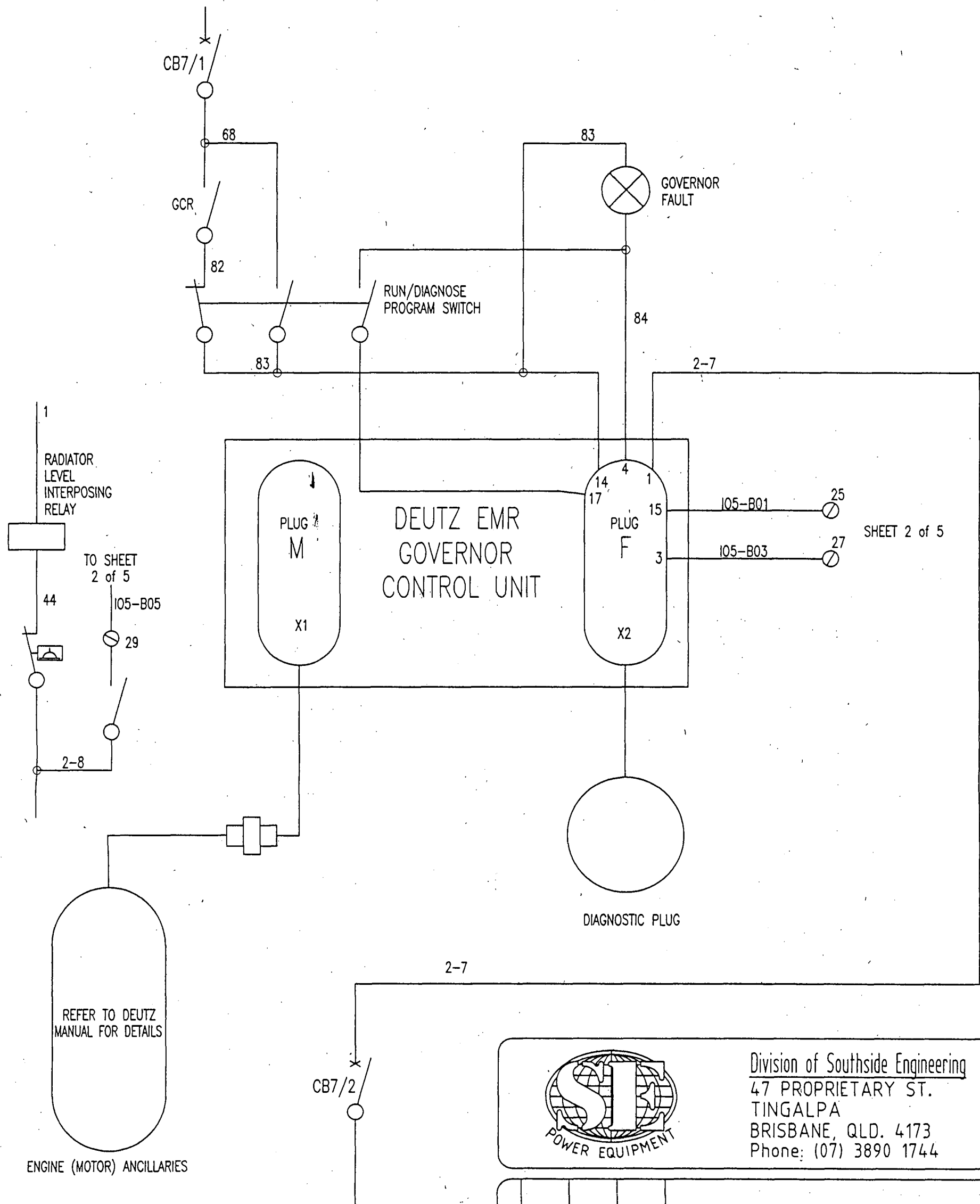
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| No | DATE     | DESIGN REVIEW | REV'D P.MGR | AMENDMENT                         |
|----|----------|---------------|-------------|-----------------------------------|
| D  | 1-9-03   |               |             | AS BUILT                          |
| C  | 14-06-03 |               |             | LOAD PULSE CONTROL UNIT WAS ADDED |
| B  | 15-05-03 |               |             | DRAWING FINALISED                 |
| A  | 08-05-03 |               |             | NEW DRAWING                       |

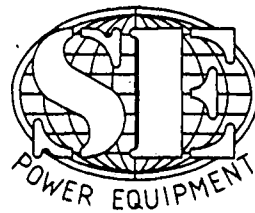
|                                |                |                      |                           |
|--------------------------------|----------------|----------------------|---------------------------|
| CLIENT B.C.C. BRISBANE WATER   |                |                      |                           |
| PROJECT PUMP STATION GENERATOR |                |                      |                           |
| DRAFTER HJR                    | DRAFTING CHECK | EPAC JOB NUMBER 4000 | SE POWER JOB NUMBER 28396 |
| DESIGNED HJR                   | DESIGN REVIEW  |                      |                           |

|                                       |                     |                  |        |
|---------------------------------------|---------------------|------------------|--------|
| TITLE BARBER COLMAN GOVERNOR CONTROLS |                     |                  |        |
| SCALE NTS                             | DRAWING No 14291-02 | No IN SET 5 of 5 | AMDT D |





SHEET 2 of 5



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| No | DATE     | DESIGN REVIEW | REV'D P.MGR | AMENDMENT                                  |
|----|----------|---------------|-------------|--|
| D  | 1-9-03   |               |             | AS BUILT                                   |
| C  | 15-08-03 |               |             | RADIATOR LEVEL INTERPOSING RELAY WAS ADDED |
| B  | 15-05-03 |               |             | DRAWING FINALISED                          |
| A  | 08-05-03 |               |             | NEW DRAWING                                |

|                 |                        |                    |                        |
|-----------------|------------------------|--------------------|------------------------|
| CLIENT          | B.C.C. BRISBANE WATER  |                    |                        |
| PROJECT         | PUMP STATION GENERATOR |                    |                        |
| DRAFTER<br>HJR  | DRAFTING CHECK         | EPAC<br>JOB NUMBER | SE POWER<br>JOB NUMBER |
| DESIGNED<br>HJR | DESIGN REVIEW          | 4000               | 28396                  |

|              |                             |                     |           |
|--------------|-----------------------------|---------------------|-----------|
| TITLE        | DEUTZ EMR GOVERNOR CONTROLS |                     |           |
| SCALE<br>NTS | DRAWING No<br>14291-02      | No IN SET<br>4 of 5 | AMDT<br>D |







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PO Box 3306 Tingalpa B.C. Qld 4173

## SEP.009/B

DATE: 4/08/03

JOB NO: 14291

ENG. SERIAL NO: 732259

ALT. SERIAL NO: 32045

[illegible]

TESTING OFFICER: JOHN BOUTH





# DIESEL GENERATOR SET LOAD TEST REPORT

SEP 0064/D

47 Proprietary Street  
Tingalpa Q 4173  
BRISBANE AUSTRALIA

CLIENT: BRISBANE WATER SP078 DATE: 4/08/03  
 SERIAL NO: 0308001 JOB NO/CONTRACT NO: 14291  
 ENGINE TYPE: 6068T ENG. SERIAL NO: 732259  
 ALTERNATOR TYPE: 274E ALT. SERIAL NO: 32045  
 GOVERNOR TYPE: G.A.C. STARTER MOTOR: STD  
 OVERSPEED TYPE: " UNDERSPEED TYPE: PLC  
 SHUTDOWN SOLENOID: " HIGH WATER: VDO  
 LOW OIL PRESSURE SHUTDOWN: 408BS

A: 132 + 10% KW: 95 kWe + 10%

TECHNICIAN: \_\_\_\_\_

INSPECTOR: PAUL HLAUKA

| TIME                     | 1315              | 1330              | 1400        | 1430          | 1500        | 1530        | 1600        | 1605        |  |  |
|--------------------------|-------------------|-------------------|-------------|---------------|-------------|-------------|-------------|-------------|--|--|
| OIL PRESSURE             | 450               | 350               | 290         | 260           | 250         | 250         | 250         | 250         |  |  |
| OIL TEMPERATURE          | /                 | NA                | /           | /             | /           | /           | /           | /           |  |  |
| JACKET WATER TEMPERATURE | 0                 | 75°               | 80°         | 80°           | 80°         | 85          | 85          | 80          |  |  |
| amps                     | 0                 | 65                | 64.9        | 106.9         | 133.9       | 133.6       | 140.6       | 0           |  |  |
| VOLTS<br>414.8           | 240<br>239<br>240 | 240<br>239<br>240 | ✓<br>✓<br>✓ | 239<br>✓<br>✓ | ✓<br>✓<br>✓ | ✓<br>✓<br>✓ | ✓<br>✓<br>✓ | ✓<br>✓<br>✓ |  |  |
| AMBIENT TEMPERATURE      | 20°               | 20°               | 20°         | 20°           | 20°         | 18°         | 18°         | 18°         |  |  |
| HZ                       | 49.9              | 49.7              | 49.7        | 49.9          | 49.9        | 49.9        | 50          | 49.9        |  |  |
| Kw                       | 0                 | 45.8              | 45.8        | 75.3          | 96.7        | 96.5        | 99.5        | 0           |  |  |
| LOAD%                    | 0                 | 50%               | 50%         | 75%           | 100%        | 100%        | 110%        | 0           |  |  |
| REMARKS                  |                   |                   |             |               |             |             |             |             |  |  |





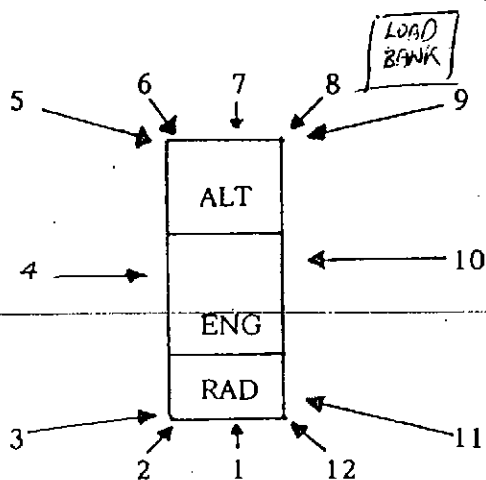
## GENERATOR SET

SEP 0023/D

## SOUND PRESSURE LEVEL TEST REPORT

47 Proprietary Street  
Tingalpa Q 4173  
BRISBANE AUSTRALIA

CLIENT: BEIS - WATER SP078 DATE: 4/08/03  
SERIAL NO: 0308001 JOB NO: 14291  
ENGINE TYPE: 6068T ENG. SERIAL NO: 732259  
ALTERNATOR TYPE: 274E ALT. SERIAL NO: 32045  
SOUND LEVEL INSTRUMENT: RION - NL



Position Layout

## Remarks:

Distance: 7 mHeight: 1.5 m

LOAD BANK COOLING FAN ADDS APPROX 6-10 DB(A)  
TO SOUND TEST

| POSITION | SOUND LEVEL<br>dB(A)                            | LOAD % |    |    |     |     |
|----------|---|--------|----|----|-----|-----|
|          |   | 25     | 50 | 75 | 100 | 110 |
| 1        | 69.9  |        |    |    |     |     |
| 2        | 67  |        |    |    |     |     |
| 3        | 67  |        |    |    |     |     |
| 4        | 69.9  |        |    |    |     |     |
| 5        | 71.9  |        |    |    |     |     |
| 6        | 71.9  |        |    |    |     |     |
| 7        | 71.9  |        |    |    |     |     |
| 8        | 71.9  |        |    |    |     |     |
| 9        | 71.9 (WITH LOAD BANK) 65.9 (WITH OUT LOAD BANK) |        |    |    |     |     |
| 10       | 71.9  |        |    |    |     |     |
| 11       | 71.9  |        |    |    |     |     |
| 12       | 71.9  |        |    |    |     |     |
| Average  |   |        |    |    |     |     |

QUALITY ASSURANCE OFFICER: \_\_\_\_\_

CUSTOMER TESTING OFFICER: \_\_\_\_\_

TESTING OFFICER: PAUL HLAVKA AAWITNESS TESTING OFFICER: DAVID COOPER



47 Proprietary Street  
Tingalpa Q 4173  
BRISBANE AUSTRALIA



SEP 0013

### FINAL INSPECTION CHECKLIST

This form is to be completely filled out before any generating set leaves the factory.

It is to be signed by the person doing the inspection and by their immediate supervisor. In the case of a non-standard job it must also be signed by the Special Projects Manager or the Engineering Manager.

A copy of this form is to be sent out with the plant concerned.

Please neatly tick in the boxes provided where applicable and note any comments in the space provided.

MODEL: S1078 SERIAL NO: 0308001 ENGINE NO: 732259  
JOB NO: 14291 DATE: 4/8/03 CUSTOMER: B.W.

#### BASE

- (1) All welds continuous, neat and clean.
- (2) All bolts tightened.
- (3) Bearers completely secured.
- (4) No sharp corners.

#### RADIATOR

- (1) Radiator correctly mounted.
- (2) All pipework included and secure.
- (3) Drain plug in place.
- (4) Water removed from radiator.
- (5) Clamps on hoses tight.

#### ENGINE

- (1) Fan is correctly mounted.
- (2) All guards in place and secure.
- (3) Wiring loom is correct to drawing, securely fixed and marked and is terminated in an appropriate terminal box.
- (4) Battery leads attached and secure and long enough for termination to battery.
- (5) Air cleaner is properly mounted.
- (6) Magnetic pickup is fitted and set to correct depth.
- (7) Exhaust pipe and silencer (where required) are fitted correctly.
- (8) Dip stick in place.
- (9) Oil removed from engine.
- (10) All fuel and oil unions completely tightened.
- (11) All ordered options are fitted and function correctly.
- (12) All parts secure, no damage.
- (13) All earths less than 0.1 ohms.
- (14) Cables and hoses secure for transport.

#### CONTROL SYSTEM (where applicable)

- (1) Control functions as ordered.
- (2) Control is mounted correctly.
- (3) All leads, terminals, fuses, printed circuit boards and switchgear are completely secure and marked correctly.
- (4) Dust seals are fitted around doors.
- (5) Doors hinged correctly.
- (6) All earths less than 0.1 ohms.
- (7) Red Danger labels in cubicle.

(8) Perspex shield secure, clean and no sharp corners.  
(9) Cables correct, no damage.  
(10) Locks and keys satisfactory.

- (1) Alternator is correctly mounted.
- (2) Alternator leads are correctly mounted inside terminal box and marked correctly.
- (3) A.V.R. is mounted, connected properly and set to correct setting.
- (4) Coupling and adaptor are properly fastened between engine and alternator with correct size and tensile grade bolts.
- (5) All options ordered are fitted and function properly.
- (6) Alternator is correctly wired for the appropriate voltage as per either Order or Bills of Material.
- (7) Earth stud fitted.

- (1) Plant is painted to correct colour.
- (2) All blemishes in finish, especially paint runs, are completely removed.

- (1) Genset is manufactured to correct engine/alternator/radiator/bases configuration as specified on Bill of Materials.
- (2) All documents are in a sealed plastic bag and secured inside alternator terminal box.
  - a) Engine Handbook
  - b) Alternator Handbook
  - c) Warranty Card
  - d) Packing List
  - e) Test Sheet
- (3) No Oil/No Water label is attached to positive battery lead.
- (4) All labels are straight and in correct location.

SIGNED: PAUL HLAVKA INSPECTOR

## QUALITY ASSURANCE

COMMENTS:





47 Proprietary Street  
Tingalpa Qld 4173  
PH: (07) 3890 1744

SEP0084

## TRANSIENT LOAD RESPONSE TEST SHEET

Transient response for load changes: Load PF 0.8

| % Change Electrical kW  | 0-25 | 0-50 | 0-75 | 0-100 | 100-0 | 75-0         | 50-0 | 25-0 |
|-------------------------|------|------|------|-------|-------|--------------|------|------|
| Change in Electrical kW |      |      |      |       |       | <del>X</del> |      |      |
| % Change HZ             |      | 3    | 4    |       |       | 4            | 2.5  |      |
| % Change Volts          |      | 4    | 4    |       |       | 4            | 4    |      |
| Recovery secs           |      | 5    | 5    |       |       | 4            | 5    |      |

CLIENT: BRISBANE WATER SP078

JOB NO: 14291

S/N: 0808001

